# EDITORIAL

WAR-SAVINGS certificates are now on sale at post-offices, banks, and many stores. The present price is $4.12, and they are redeemable on January 1, 1923, at $5.

THE American Society of Civil Engineers is now in its new home, in the Engineering Societies building, 239 West 39th street, New York. The first regular meeting to be held in the new quarters was on November 7.

FEDERAL farm loans made during October amounted to $7,374,044. The total amount loaned since the law went into effect is $21,040,138, of which $1,248,200 has been placed through the Berkeley Federal Land Bank, and $3,849,590 through the Spokane bank.

NAILED joints have been used for several thousand years in building operations, but comparatively little is known about their strength, and still less about the special case of the strength of joints in douglas fir and western hemlock. The article by Mr. H. F. Blood and Mr. H. E. Plummer supplies the desired information.

MECHANICS of various trades are needed for service in the Enlisted Ordnance Corps of the National Army. This is an excellent opportunity for qualified men between the ages of 18 and 40 to serve their country. Further information may be obtained from the Chief of Ordnance, War Department, Washington, D. C. Men enlisting will see service in Europe.

SERVICE-TESTS of the new military motor-trucks have been made since the article in this issue describing these trucks went to press. The tests passed satisfactorily by the trucks included going in and out of a ditch four feet deep and seven feet wide, and climbing a 19% grade on the second speed. It was also found that 40-inch wheels gave better speed and traction than the 36-inch wheels used at first.

EVAPORATION must be considered in almost all hydraulic work. In such work, the hydraulic engineer depends upon rather fragmentary experimental data. Furthermore, local conditions have so much effect upon the rate of evaporation that the results obtained by different investigators differ widely, and it is hard to find a basis for comparing them. The effect of this has been that many of the assumptions made regarding safe draft on reservoirs have been founded on little more than guesswork. In this number appears a report of an investigation by Mr. R. B. Sleight, which we believe to have been the most complete that has ever been made, and which furnishes a really rational basis for calculations of evaporation.

MR. BARNESON'S article is commended to students of the oil industry and particularly to those who believe that the safety of the United States Navy in some crisis in the distant future depends upon locking up Naval Reserve No. 2 in the Buena Vista Hills. We need a great deal more oil than we are producing at the present time. If drilling efforts are scattered over the fields of the State it is not probable that this additional production can be obtained within a reasonable time. It can be obtained by concentrating work as far as possible in the Buena Vista Hills. Since this land is included in Naval Reserve No. 2, Congressional action is necessary. Further delays in this matter are a direct hindrance to winning the War.

THE eight-hour day has been adopted in the Californian oilfields at a conference between representatives of the employers and workmen, and the Federal mediator, Mr. Verner Z. Reed. This part of the agreement goes into effect on January 1, with the proviso that, if production cannot be maintained under these conditions, the workmen affected shall, upon request of the Federal Government, work as many hours as may be considered necessary, upon terms to be fixed by the Federal Government. Other parts of the agreement provide for a minimum wage of $4 per day, effective December 1, and also establish 'open-shop' conditions with no discrimination against either union or non-union men.

CONCRETE HIGHWAY construction of an unusual kind is to be undertaken by Sacramento county. The County Highway Commission is to receive bids on the tenth of this month for building 13 miles of highway on top of the levee on the bank of the Sacramento river. All materials must be brought to the work by water. No grading will be required except shaping the roadbed, since the reclamation district will finish the levee to a uniform grade. Probably the best method of laying concrete pavement will be by placing a mixing-plant on a barge, and 'spouting' the concrete to the top of the levee. Besides the present contract, 17 miles more highway is to be constructed under similar conditions.

CHRISTMAS stands for much of the best and some of the worst things that we do. Some of the attendant bartering of gifts was disgraceful at any time, much of it was perhaps excusable in other years, but

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not in this blackest Christmas the world has known for centuries. A group of industrial companies in Chicago have announced that they will not send Christmas cards this year, but give the money to various war-relief organizations. This is a good example for us all to follow. Let us give the children a good time, see that adults less fortunate than ourselves have been cheered, and then give the rest of our Christmas money to the Red Cross, or the Young Men's Christian Association, or whatever organization appeals to us most. Even buying Liberty Bonds, while a rather subdued way to celebrate, is better than some of the Christmas expenditures of quieter and, perhaps, more selfish years.

## Completion of the Australian Trans-Continental Railroad

Although the War has engaged the main attention of Australians during the past three years, they have also been able to complete the railroad from Kalgoorlie, Western Australia, to Port Augusta, South Australia. Travel by rail from Freemantle, Western Australia, across the continent to Melbourne and Sydney, and to Longreach, Queensland, is now feasible, but changes of cars are necessary because of difference of gage.

Construction was commenced in 1912, and the line was formally opened to traffic in November of this year, although ballasting has not been completed. The total length is 1052 miles, of which 454 miles is in Western Australia, and 598 miles in South Australia. The maximum grade is 1¼%, and the maximum curvature 4° 20′, but there are only two curves as sharp as this. The 330-mile tangent across the Nullabor plain is the longest in the world. The grading and bridge-work required were comparatively light, but transporting supplies was difficult. From Kalgoorlie east for nearly 800 miles, the line runs through an almost uninhabited desert. The longest stretch without any local supply of water was 337 miles. Wells have now been drilled along the line. Some of them are as much as 1500 feet deep.

## Rules for Expediting the Movement of Freight

The Railroads War Board has issued the following instructions to the railroads of the country:

1. Comply promptly with all priority and governmental orders and orders of the Commission on Car Service.

2. Increase loads per car, expedite movements through yards and terminals, and enforce demurrage rules.

3. Unload company material more promptly.

4. Increase loading of cars carrying less-than-carload shipments by establishing 'sailing days' for this class of shipments.

5. Increase fuel economy.

6. Review switching service at terminals and arrange special movements to avoid unnecessary detention of cars.

7. Conserve transportation by avoiding circuitous routes, but do not overload direct routes.

8. During the winter lengthen passenger and fast-freight schedule in order to promote punctuality and to avoid demoralization of traffic consequent upon trains being late.

9. Arrange for common use of terminals and facilities.

10. Reduce re-consignment privileges.

11. Encourage use of motor trucks and trolley lines for handling short-haul freight.

12. Enlist services of water-transportation lines.

13. Advocate the use of universal inter-line way-bills.

14. Keep seaport and regional gateways free of congestion by prompt use of embargoes at the first sign of trouble, instead of waiting for congestion actually to develop.

## Saving Gasoline

The following rules for saving gasoline are suggested by the United States Food Administration:

1. Store gasoline in underground steel tanks. Use wheeled steel tanks with measuring-pump and hose. They prevent loss by fire, evaporation, and spilling.

2. Don't spill or expose gasoline to air; it evaporates rapidly and is dangerous.

3. Don't use gasoline for cleaning and washing; use kerosene or other materials to cut grease.

4. Stop leakages. Shut off gasoline at the tank or feed-pipe.

5. Adjust brake-bands so they do not drag. See that all bearings run freely.

6. Don't let engine run when car is standing. It is good for the starter-battery to be used frequently.

7. Have carbureters adjusted at service-stations of carbureter or motor-car companies; they will make ordinary adjustments without charge.

8. Keep needle-valve clean and adjust carbureter (while engine is hot) to use as lean mixture as possible. A rich mixture fouls the engine and is wasteful.

9. Pre-heat the air entering the carbureter and keep the radiator covered in cold weather; this will insure better vaporization.

10. See that the spark is timed correctly with the engine. Drive with spark fully advanced; a late spark increases consumption of gasoline.

11. Have a hot spark, keep plugs clean, and spark-points properly adjusted.

12. Avoid high speed. The most economical speed for the average car is 15 to 25 miles per hour.

13. Avoid either accelerating or stopping the engine quickly; its wastes gas and wears out tires. Stop the engine and coast on long hills.

14. Reduce aimless and needless use of cars. Do a number of errands in one trip.

15. Know your mileage per gallon. Fill the tank full and divide the odometer mileage by the number of gallons consumed.

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# REVIEW OF THE MONTH

OIL-PRODUCTION statistics continue to show the need of more development work. In spite of the completion of an 8000-barrel well in the Montebello field, the average daily production for California was 6000 barrels less than in September. Stocks were reduced 1,000,000 barrels during October. It is nearly seven years since the stock of oil on land has been as low as it is now, and at that time, consumption was about two-thirds of what it is at present.

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CO-OPERATION among engineering societies is increasing throughout the world. The latest development in this line is in Australia. Engineering societies have developed in various parts of the Commonwealth without any particular co-ordination between the different organizations. Some are confined to one State, but include all branches of the profession. Others have members and local organizations in two or more States, but include only one kind of engineers. The suggestion has now been made to form an engineering institute for the entire Commonwealth including all branches of engineering, the local organizations to become members of this institute, but to retain their identity.

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THE American Highway Association has disbanded. It was organized in 1910 to promote efficient road administration in the United States. Now that each State has a regularly organized Highway Department, working in co-operation with the United States Office of Public Roads, the members have decided that the principal object of the Association has been accomplished. The funds belonging to the Association are to be used for a medal to be awarded annually for conspicuous service in the advancement of road improvement in the United States. The Good Roads Year Book, one of the most important of the activities of the Association, has been turned over to the D. Van Nostrand Company.

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ONE beneficial result of the War has been the forgetting of a number of minor disputes among ourselves in the need for meeting the common enemy. This was recently illustrated in the Tulare Lake region. The Lake Land canal was constructed in 1903, to take water from Kings river, but it has never been used because of an injunction obtained by riparian owners on the lower part of the river. Even when the water in the river was so high as to be a menace to the surrounding country, the owners of the Lake Land canal were not allowed to take the water that they needed to irrigate their land. This seems like a 'dog in the manger' policy on the part of the riparian owners, but they had good reason to hesitate about making any concession that might endanger their own claims to the water in the river, claims that had been established only by long and expensive litigation. This unsatisfactory state of affairs might have continued indefinitely but for the War and the resulting demand for increased production of food. Now, however, the riparian owners and other interested persons have agreed that when the flow in the Kings river exceeds the capacity of the other canals, about 7000 second-feet, the excess flow or any part of it may be diverted by the owners of the Lake Land canal. While the agreement stipulates that it shall be effective only during the War, it is to be hoped that some means may be devised for making it permanent, while at the same time preserving the rights of the other water-users on the river.

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SOME pipe-lines for carrying oil are common carriers, and some are not, according to recent decisions by the State Supreme Court of California. In 1913 the legislature passed an amendment to the Public Utilities Act declaring all pipe-lines common carriers, and, as such, subject to the jurisdiction of the State Railroad Commission. With the exception of the Standard Oil Company, all the pipe-line companies in the State attacked the constitutionality of the law in the courts. The Standard Oil Company filed under protest a schedule of charges for transporting oil with the State Railroad Commission, but, on account of the suits brought by the other companies, nothing further was done. In the decisions just rendered, the Producers' Transportation Company is declared to be a common carrier for three reasons; first, because of provisions in its incorporation papers, second, because it carries oil for hire, and third, because of its appeal to the right of eminent domain in a condemnation-suit decided in its favor. The condition of Agency membership, required before carrying a producer's oil, the Court holds to have been simply a regulation, since such membership was never denied to a producer that fulfilled the necessary conditions. On the other hand, the Court holds that the Associated Pipe Line Company is not a common carrier. At the time of going to press, no other decisions had been rendered, but it is reasonable to suppose that the other companies will be classed with the Associated company.

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WHAT will be the effect of these decisions on the oil industry of the State? Probably no good at all, and little, if any, harm. Membership in the Independent Producers' Agency, as has been mentioned already, is open to every producer. Probably the State Railroad

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Commission will establish a rate for transportation alone that will be somewhat less than the rate charged by the Agency for both transportation and marketing. It is not likely that the Railroad Commission will compel the Agency to accept oil that it cannot transport without neglecting the interests of its own members. Nevertheless, the Producers' Transportation Company lines may have some surplus capacity, and it is possible that some producers will prefer to pay for transportation only and store and peddle their own oil rather than to join the Agency, and pay a little more, and have both transportation and marketing done for them. It is also possible, although not at all probable, that these operators will enjoy handling their own marketing problems so well that they will continue the arrangement for more than a few months. Experience in other States, where common-carrier laws are in effect, however, indicates that this is not likely. Shipments of privately owned oil are seldom, if ever, offered to the pipe-line companies.

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IF all signs fail, and the common-carrier law actually has some effect in California, the Producers' Transportation Company is going to have a great deal of trouble. In most of the Eastern States, the oil from any one field is approximately uniform both in gravity and gasoline content. In the Californian fields, on the contrary, not only do the oils from the different fields and from different parts of the same field vary considerably in gravity and gasoline content, but the gasoline content of the oils of the same gravity also varies. When shipments of different kinds of oil follow each other through the same pipe-line, some mixing of the shipments is sure to occur. This is not objectionable when all the shipments are owned by one concern, but when a line is operated as a common carrier, the delivery to each shipper of the same grade of oil as was originally received from him present many interesting and hitherto unsolved problems.

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FREIGHT-CAR shortage, in spite of the efforts of the Railroads' War Board, has again become serious. Excess of unfilled car-orders was 148,000 on May 1, shortly after the Board took charge of the railroads of the country. Freed from governmental interference for the first time in many years, the railroads attacked the transportation problem with such vigor that, in the face of increasing traffic, the shortage was reduced to 31,000 cars on September 1. Then came the annual crop-movement and the transportation of men and supplies to mobilization camps. The shortage increased to 140,000 cars on November 1, and is probably worse yet by this time. At this time the member from Podunk rises to inquire why the railroads do not get some more cars. The answer to this is in two parts: first, the railroads are buying and building cars as fast as possible, and, second, the situation cannot be remedied simply by having more cars. More locomotives, additional tracks, better terminal facilities, and more equipment in general must be obtained by the railroads. The general public is just beginning to recognize these facts, although they have been known by railroad officials for years. But to buy equipment requires money, and railroad securities have not been attractive investments in recent years, nor are they likely to be until the railroads are permitted to charge rates that will be more remunerative than those in force now. It is to be hoped that this will be done in the near future.

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MEANWHILE such drastic measures as embargoes on various materials have become necessary. Since winter is approaching, coal naturally has the right of way over many other commodities, and this has led to a much-discussed order by the War Industries Board. This order prohibits the use of open-top cars for transporting highway materials. Except where the work is near a navigable stream, or is near enough to local deposits of road materials to permit economical transportation by motor-trucks, the effect of this order has been to cripple the work of constructing surfaced highways. Possibly this order had become necessary, at least as a temporary measure, but it is to be hoped that the embargo can be raised soon, or at least before the beginning of active construction next spring. Bad as transportation conditions are, they would be much worse but for the increasing use of motor-trucks, and the part played by motor-trucks can be rendered even more important if the number of 'all-weather' highways is increased.

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MOTOR-TRUCK transportation is no longer confined to comparatively short hauls. Many of our readers have heard of the trains of trucks now being operated by a well-known rubber company between Akron and Boston. A regular schedule is maintained, the round trip, 1510 miles, being made each week. Four trucks are used and more have been ordered. The company started to use the trucks in April and hopes to continue operating them during the winter. Of the entire distance, only 28 miles is unimproved, but even this may compel suspension of the service if the snow gets deep.

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BAD ROADS on less than 4% of the route may therefore prevent the highways on the entire distance from being used at their greatest efficiency. This is typical of conditions throughout the country wherever the expenditure of highway funds has been ordered with an eye to placating the largest number of voters rather than in accordance with a comprehensive plan for serving the transportation-needs of the community in the best possible way. To build several unconnected stretches of good roads that begin nowhere and end nowhere may be almost as much a misuse of the public funds as if the same amount of money had been actually stolen. Fortunately the establishment of highway departments in every State, working in conjunction with the United States Office of Public Roads has eliminated the old-style system as far as State work is concerned, and even the counties are generally realizing that their work also should be co-ordinated.

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# DISCUSSION

## The Portland Ordinance Permitting Mill-Construction Buildings Within the Fire-Limits

The Editor:

Sir—The October number of WESTERN ENGINEERING contains an editorial paragraph on page 372 commenting on the mill construction ordinance recently enacted at Portland. This ordinance, in brief, permits the construction of mill-construction buildings with masonry-walls and sprinkler-systems not more than four stories high within the fire-limits. As secretary of the committee appointed to further the passage of this ordinance, I would state the following:

This ordinance was passed after careful investigation and discussion of the subject extending over a period of two years. It was found that Portland was the only city of its size or larger that did not permit mill-construction buildings within the fire-limits. Minneapolis permits one-story buildings of either mill or joist construction. Seattle permits two-story buildings of mill construction. All other cities permit mill-constructed buildings of four stories or higher.

As regards the actual fire-hazard, the following insurance-rates were quoted by the Portland Rating Bureau on an assumed furniture-store occupancy:

ON BUILDING

| | Unsprinklered | Sprinklered |
|---|---|---|
| Mill construction ..... | 0.47 | 0.28 |
| Fireproof construction ..... | 0.35 | 0.21 |

The following rates were quoted by the Chicago Rating Bureau on an assumed machine-shop occupancy:

ON BUILDING

| | Unsprinklered | Sprinklered |
|---|---|---|
| Mill construction ..... | 1.11 | 0.15 |
| Fireproof construction ..... | 0.24 | 0.14 |

ON CONTENTS

| | Unsprinklered | Sprinklered |
|---|---|---|
| Mill construction ..... | 1.36 | 0.30 |
| Fireproof construction ..... | 0.64 | 0.26 |

In each case the rate on the sprinklered building of mill construction was less than the rate on the unsprinklered building of fireproof construction. This latter type of building is permitted within the fire-limits by both the old and the new ordinances. The small difference between the rates on the sprinklered fireproof building and the sprinklered mill-construction building is noticeable. As a general rule it may be stated the saving of insurance in substituting fireproof for mill construction in sprinklered buildings is not enough to pay interest on the difference in the cost of the two types.

Records kept for the past 20 years have shown that in 95 cases out of 100, sprinklers have either extinguished a fire or prevented it from spreading until help arrived.

Study of the last two important fires in mill-construction buildings at Portland shows that in one case the fire reached only 37% of the floor-area, and in the other only 28%, although in both cases the buildings were filled with smoke and covered with water. In each case the structural damage was less than 15% of the total loss.

It has been stated that while a mill-construction building is nearly as safe from fires from within as a fireproof building where both are sprinklered, and safer where the fireproof building is unsprinklered, nevertheless, that the use of mill-construction buildings increases the conflagration hazard. However, a study of the fires at Baltimore, San Francisco, Salem, and Chelsea shows that no building, fireproof or non-fireproof, of the type permitted in the Portland fire-district stopped the flames for an instant. Adequately to provide for the conflagration hazard by means of building laws alone would be financially impracticable in any city.

It has also been stated that the passage of the new ordinance is an injustice to the owners of fireproof buildings. Most of the fireproof buildings within the fire-limits are more than four stories high and there is no direct competition. In general, the result of the ordinance will be to permit the replacement of inferior buildings by mill-construction buildings in cases where it has been impossible to raise the necessary money to proceed with fireproof construction. The general effect should be the improvement of property and the reduction of insurance rates within the district. That most of the owners recognized this is shown by the fact that the Building Owners and Managers Association favored the passage of the new ordinance.

O. G. HUGHSON,
Manager Builders Exchange.

Portland, Oregon, October 27.

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## Hydraulic Lime for Shutting Off Water in Oil-Wells

The Editor:

Sir—It has come to my notice that hydraulic lime has been used in connection with cement, for shutting off water in oil-wells. It was placed, in one case, behind the water-string and above the cement for the purpose of filling crevices in the shale.

I would like information as to the composition of hydraulic lime, its gravity, time of setting, volume-changes, chemical effect on iron, steel, and cement, and any other data that have a bearing on the problem at hand.

ENGINEER.

Santa Maria, California, November 19.

[This use of hydraulic lime differs so much from the

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more common one of promoting the plasticity of concrete in pavements, tunnel-lining, and other places where a thin slab is employed that the question is referred to our readers.—EDITOR.]

## THE CHEMICAL EXPOSITION

By M. W. von BERNEWITZ

Fully 100,000 people, of whom 25% were men of special scientific training, received inspiration at the third National Exposition of Chemical Industries held at the Grand Central Palace, New York, during the week of September 24. At no time was the place crowded, but those in attendance appeared bent upon studying what was presented. There were meetings of scientific societies, moving pictures illustrating various industries, and over 400 booths containing an aggregation of apparatus used in chemical manufacturing; therefore visitors could not complain of a lack of variety. There is no doubt that the show was a success, which gives encouragement for promoting another in 1918. Broadly speaking, the exhibits might be classed under eight groups; for example, dyes and colors, instruments, acid-proof apparatus and connections, glass, porcelain, and silica-ware, refractories, metals, ore-treatment apparatus, insulating materials, and by-products. The first of these was shown in about 25 booths, the products being in bottles and in various cloth, silk, and leather materials. Dye manufacturers were probably the most prominent of any exhibitors. Instrument-makers were in force, showing the latest ideas in balances, control, electrical, liquid, temperature, and vacuum-measuring devices, some of which were to be seen in operation. Measuring temperature by radiant heat was of interest. A dozen firms showed chemicals, including explosives. A demand is increasing for acid-proof apparatus, such as evaporators, heaters, pumps, and pipe connections. These were shown as special iron compounds, enameled iron, lead, and earthenware, some of the last being cleverly made. There was also acid-proof cloth. Considerable laboratory glassware was on view, and porcelain for all purposes. Silica-ware, both transparent and opaque, was keenly examined. This, as most chemists know, is made from pure quartz. It will stand great variations in temperature without cracking, is proof against all acids save hydrofluoric and phosphoric, and is superseding platinum for many purposes. Refractories included ores and brick. Several well-known smelting concerns had excellent exhibits of electro-spelter, copper, and lead. Much interest was taken in the spelter, the latest metallurgical triumph on a large scale. Millmen had a chance to see in operation ball-mills, concentrators, flotation machines (the odor of the oil sufficing to direct one to the place), and filters. Cyanide (30%), made from cyanamid, was on view. It is blackish and reminds one of the salt produced 20 years ago. The 52% salt was also shown. Smoke-farmers could see how their damage-suits are going to lapse by reason of the well-known precipitator. Several types of smoke-helmets were demonstrated in a practical way. Insulating materials included rubber, vulcanite, bakelite, and brick. Tungsten producers had a chance to see 99% acid ($WO_3$), a canary-yellow powder worth $1.50 per pound. By-products were shown by numbers of manufacturers. Smelters displayed gold, silver, platinum, bismuth, tellurium, and the like, all recovered during the refining of base metals. Perhaps the most interesting by-product exhibit was one arranged like a family tree, showing actual specimens of the derivatives from coal, including coke, tars, oils, colors, disinfectants, drugs, explosives, and many other things.

It would be unkind to indulge in much criticism of such an exposition, but as an unbiased spectator during four days some defects were apparent. The ramifications of chemistry are far-reaching, but a line should be drawn somewhere; and such exhibits as 50-ton evaporators, large mixing, drying, and centrifugal machines, elevators, trucks, corn products, engineering firms, Japanese chemicals, milling and treatment-machinery for mines, and excessive space occupied by the Southern States and railroads showing their mineral resources, it would seem might better be shown elsewhere, and the space so occupied filled with matter pertaining to the real chemical industries. A number of the large chemical firms was conspicuous by being absent. These should be in evidence at future expositions.

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**Failures in the crank-shafts** of Diesel engines, according to a writer in the 'Petroleum World,' in a large number of cases are the result of slipping of foundations. Special attention ought therefore to be paid to reinforcing the concrete around the weakest section of the foundation-block, namely, the fly-wheel pit. The foundations of the engine should be one continuous block, designed so that if slipping occurs, there is a bodily, rather than a local, displacement of the foundation. The best method of avoiding a broken shaft is to keep the bearings 'nipped' together, with running clearance only, and re-align the shaft at regular periods. The length of the period between adjustments depends upon the alignment made during erection and the attention given in service, including choice of lubricating oil. Under favorable conditions the average wear on main bearings is about 0.001 inch in 1500 hours with slow-speed engines and ring-lubrication. The bearing adjacent to the fly-wheel may wear at double that rate.—'Mechanical World.'

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**The production** of natural asphalt in the United States in 1916 was 98,477 tons. The production of asphalt manufactured from domestic petroleum was 688,334 tons, while the asphalt from Mexican petroleum was 572,387 tons. The production of manufactured asphalt was the largest on record, while the production of natural asphalt was only slightly smaller than that of the record year, 1909, 99,061 tons. From Trinidad, 92,858 tons was exported to the United States, and 36,626 tons from Venezuela. The amount imported into the United States from other countries was negligible.

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# Recent Bids on California State Highway Work—Part II

This month's summary of State highway bids comprises those received between September 4 and November 12, inclusive. Bids for more work were received on November 26 and additional contracts will probably be awarded during the winter, but it is hardly likely that actual construction on any other work will be started this season. For convenience, the same reference numbers are used as in the July and November numbers, as follows:

(4) Palmer & McBryde, San Francisco.
(5) Tieslau Bros., San Francisco.
(7) Bates, Borland & Ayer, Oakland.
(19) Robert Sherer, Los Angeles.
(28) W. A. Dontanville, Salinas.
(32) W. A. Bechtel, San Francisco.
(37) A. L. McCray, Los Angeles.
(38) Richard Rothwell, Los Angeles.
(39) W. M. Ledbetter, Los Angeles.
(42) Holland Construction Co., San Diego.
(43) C. L. Hyde Construction Co., San Diego.
(44) Municipal Improvement Co., Richmond.
(47) A. Robinson and R. R. Smith, Fortuna.
(48) J. A. Marshall, Berkeley.
(49) A. J. Fairbanks, Willitts.
(50) F. Rolandi, San Francisco.
(51) Edmund J. Treacy, San Francisco.
(52) George R. Curtis, Los Angeles.
(53) Fred Hoffman, Long Beach.
(54) Shattuck-Edinger Co., San Francisco.
(55) Tibbitts-Pacific Co., San Francisco.
(31) Engineers' estimate.

The following bids were received September 4 for construction of 4.5 miles of highway in San Diego county between Guatay creek and Pine valley:

| Item and quantity | (31) | (42) | (39) | (43) | (38) |
|---|---|---|---|---|---|
| Excavation, 25,500 cu. yd. | $0.60 | $0.8975 | $0.80 | $0.875 | $1.25 |
| 18-in. pipe, 784 ft. | 0.85 | 0.90 | 1.00 | 1.00 | 1.25 |
| 24-in. pipe, 475 ft. | 1.15 | 1.10 | 1.00 | 1.25 | 1.50 |
| Concrete in culverts and monuments, 146 cu. yd. | 18.50 | 15.00 | 17.00 | 15.00 | 24.00 |
| Dry-rubble masonry, 30 cu. yd. | 3.00 | 7.00 | 6.00 | 1.50 | 9.00 |
| Guard-rail, 1500 ft. | 0.60 | 0.60 | 0.60 | 0.75 | 0.90 |
| Monuments, 190 | 0.60 | 1.20 | 1.25 | 1.50 | 2.00 |
| Total | $23,365.30 | $27,642.35 | $25,458.50 | $27,335.25 | $39,071.50 |

The State furnishes pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $3212.48. Contract was awarded to W. M. Ledbetter, for $25,458.50, or a total of $28,670.98, or $6370 per mile.

The following bids were received September 11 for construction of 6.4 miles of highway between Rio Dell and Fortuna, in Humboldt county. Paving is not to be done under the present contract.

| Item and quantity | (31) | (47) | (48) | (32) | (5) | (49) |
|---|---|---|---|---|---|---|
| Common excavation, 53,200 cu. yd. | $0.47 | $0.40 | $0.59 | $0.70 | $0.78 | $0.90 |
| Borrow excavation, 20,700 cu. yd. | 0.57 | 0.80 | 0.59 | 0.90 | 1.05 | 1.30 |
| 12-in. pipe, 250 ft. | 0.40 | 0.50 | 0.40 | 0.40 | 0.60 | 1.00 |
| 18-in. pipe, 408 ft. | 0.65 | 0.75 | 0.50 | 0.50 | 0.80 | 1.50 |
| 24-in. pipe, 342 ft. | 0.85 | 1.00 | 0.60 | 0.60 | 1.00 | 2.50 |
| 30-in. pipe, 108 ft. | 1.25 | 1.50 | 1.00 | 0.70 | 1.25 | 3.50 |
| Concrete in culverts and monuments, 370 cu. yd. | 12.00 | 12.00 | 12.00 | 16.00 | 12.00 | 15.00 |
| Monuments, 119 | 0.50 | 0.50 | 1.00 | 1.25 | 0.50 | 2.00 |
| Total | $48,407.41 | $43,274.50 | $48,777.20 | $62,708.55 | $69,912.90 | $82,573.00 |

The State furnishes pipe-railing, reinforcing steel, corrugated pipe, and cement. Contract was awarded to A. Robinson and R. R. Smith, Fortuna.

On October 8, the Municipal Improvement Co. was the only bidder and was awarded the contract for construction of 7.7 miles of highway in Butte county between the southerly boundary and Biggs; at the following unit prices, the first figure being the engineers' estimate and the next the company's bid: excavation, 10,500 cu. yd., $0.75, $0.99; 12-in. pipe, 120 ft., $0.70, $0.60; 18-in. pipe, 60 ft., $0.90, $0.80; 24-in. pipe, 30 ft., $1, $1; concrete in culverts and monuments, 150 cu. yd., $10, $12.50; concrete in pavement, 7600 cu. yd., $4, $5.74; guard-rail, 200 ft., $0.35, $0.40; monuments, 58, $0.50, $2, a total of $56,240, the engineers' estimate being $46,048.30. The State will furnish pipe-railing, reinforcing-steel, corrugated-metal pipe, cement, sand, and coarse aggregate, valued at $38,286.15, making a total cost of $94,526.15 or $12,300 per mile.

The Municipal Improvement Co. was also the only

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bidder and was awarded the contract for the construction of 12.4 miles of highway in Sonoma county between Santa Rosa and Willow Brook, at the following prices, the first figure being the engineers' estimate and the second the company's bid: excavation, 42,000 cu. yd., $0.70, $0.99; 12-in. pipe, 32 ft., $0.60, $0.60; 15-in. pipe, 20 ft., $0.70, $0.70; 18-in. pipe, 370 ft., $0.80, $0.80; 24-in. pipe, 360 ft., $1, $1; concrete in culverts and monuments, 850 cu. yd., $12.50, $12.50; concrete in pavement, 12,200 cu. yd., $5, $5.60; reinforcement for pavement, 482,000 sq. ft.; $0.0015, $0.0175; guard-rail, 8000 ft., $0.40, $0.40; monuments, 131, $0.50, $2; a total of $133,111.20. The engineers' estimate was $121,558.11. The State will furnish pipe-railing, reinforcement for pavement, reinforcing-steel, corrugated-metal pipe, cement, sand, and coarse aggregate, valued at $81,312.02, making a total cost of $214,423.22, or $17,300 per mile.

The following bids were received October 8 for construction of 16 miles of highway in Marin county between San Rafael and the northerly boundary:

| Item and quantity | (31) | (50) | (4) | (49) | (51) |
|---|---|---|---|---|---|
| Excavation, 97,000 cu. yd | $0.70 | $0.85 | $0.95 | $1.00 | $1.00 |
| 12-in. pipe, 738 ft | 0.60 | 0.60 | 0.80 | 0.60 | 0.75 |
| 15-in. pipe, 746 ft | 0.70 | 0.70 | 0.90 | 0.70 | 1.00 |
| 18-in. pipe, 338 ft | 0.80 | 0.80 | 1.00 | 0.80 | 1.50 |
| 24-in. pipe, 368 ft | 1.00 | 1.00 | 1.10 | 1.50 | 2.00 |
| 30-in. pipe, 78 ft | 1.50 | 1.00 | 1.50 | 2.25 | 2.50 |
| Concrete in culverts and monuments, 795 cu. yd | 12.50 | 15.00 | 15.00 | 16.00 | 6.00 |
| Concrete in pavement, 15,700 cu. yd | 5.00 | 4.80 | 4.90 | 7.00 | 4.00 |
| Reinforcement for pavement, 195,000 sq. ft | 0.0015 | 0.015 | 0.003 | 0.02 | 0.005 |
| Guard-rail, 5225 ft | 0.40 | 0.50 | 0.50 | 0.50 | 0.70 |
| Monuments, 201 | 0.50 | 1.00 | 1.50 | 1.00 | 7.00 |
| Total | $184,622.04 | $177,154.90 | $186,625.60 | $228,296.40 | $173,347.00 |

The State will furnish pipe-railing, reinforcing-steel, reinforcement for pavement, corrugated-metal pipe, cement, sand, and coarse aggregate, valued at $103,855. Contract was awarded to Edmund J. Treacy for $173,347, or a total of $277,202 or $17,300 per mile.

On November 5, bids were opened for placing asphaltic wearing-surface on 31,700 sq. yd. of concrete base between Fresno and Malaga. The contract was awarded to Blanchard-Brown Co. for $0.72 per sq. yd. or $22,824 in all. Other bidders were Worswick Street Paving Co., $0.75 and $0.81 per sq. yd., according to type; Federal Construction Co., $1.25 and $1.30; Clark & Henery Construction Co., $1.53; California Road & Street Improvement Co., $1.62 and $1.64; and Thompson Bros., $1.62 and $1.67. The engineers' estimate was $25,518.50. The cost of this work will be about $7600 per mile.

The following bids were received November 5 for construction of 10 miles of State highway in Los Angeles county between San Fernando and Rancho Tujunga:

| Item and quantity | (31) | (52) | (53) | (37) |
|---|---|---|---|---|
| Excavation, 53,700 cu. yd | $0.40 | $0.90 | $1.00 | $0.75 |
| 18-in. pipe, 858 ft | 0.50 | 1.00 | 1.00 | 2.00 |
| 24-in. pipe, 365 ft | 0.75 | 1.50 | 1.50 | 2.00 |
| Concrete in culverts and monuments, 310 cu. yd | 14.25 | 15.00 | 15.00 | 16.00 |
| Concrete in pavement, 9800 cu. yd | 5.25 | 8.60 | 5.50 | 6.00 |
| Guard-rail, 4600 ft | 0.45 | 0.50 | 0.75 | 1.00 |
| Monuments, 170 | 0.50 | 1.00 | 1.00 | 1.00 |
| Total | $92,236.04 | $141,135.50 | $117,275.50 | $111,251.00 |

The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, and asphaltic-oil surfacing, valued at $39,422.50. Contract was awarded to A. L. McCray for $111,251, making a total cost of $150,673.50, or $15,070 per mile.

The following bids were received November 5 for construction of 15.6 miles of State highway between Garberville and Miranda in Humboldt county:

| Item and quantity | (31) | (32) | (7) | (54) | (49) | (4) |
|---|---|---|---|---|---|---|
| Excavation, 258,000 cu. yd | $0.60 | $0.85 | $0.85 | $1.10 | $0.76 | $0.715 |
| 12-in. pipe, 3250 ft | 0.70 | 1.50 | 1.50 | 1.10 | 0.70 | 0.60 |
| 18-in. pipe, 3980 ft | 0.80 | 1.50 | 1.50 | 1.32 | 1.00 | 0.70 |
| 24-in. pipe, 1450 ft | 1.10 | 1.50 | 2.00 | 1.65 | 1.50 | 0.80 |
| 30-in. pipe, 398 ft | 1.30 | 1.50 | 2.50 | 2.20 | 2.25 | 0.90 |
| Concrete in culverts and monuments, 1803 cu. yd | 15.00 | 17.50 | 22.00 | 19.80 | 16.00 | 15.00 |
| Concrete in retaining-walls, 203 cu. yd | 10.00 | 17.50 | 22.00 | 19.80 | 16.00 | 14.00 |
| Moving and re-setting property-fences, 8.5 miles | 250.00 | 250.00 | 300.00 | 220.00 | 300.00 | 225.00 |
| Monuments, 1032 | 1.00 | 1.75 | 3.00 | 1.00 | 1.25 | 1.00 |
| Total | $223,793.91 | $271,953.00 | $283,818.00 | $338,620.70 | $241,341.50 | $223,555.70 |

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The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $27,077.80. Contract was awarded to Palmer & McBryde for $223,555.70, or a total of $250,633.50, or $16,070 per mile.

On November 12, Palmer & McBryde were the only bidders at $42,359 for construction of 3 miles of highway in Monterey county near the King City bridge. The engineers' estimate was $34,042.88. The detailed figures are as follows, the first figure being the engineers' estimate, and the second the bidding price: excavation, 20,100 cu. yd., $0.45, $0.90; 12-in. pipe, 310 ft., $0.50, $0.90; 18-in. pipe, 160 ft., $0.60, $1; concrete in culverts and monuments, 280 cu. yd., $11.35, $18; concrete in pavement, 3051 cu. yd., $5.50, $6; guard-rail, 800 ft., $0.40, $0.50; monuments, 50, $0.50, $1.50 each. The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate. This bid was rejected and the work is to be re-advertised in a short time, together with other work also situated in Monterey county.

The following bids were received November 12 for the construction of 12 miles of highway in San Luis Obispo county between Arroyo Grande and the Santa Maria river:

| Item and quantity | (31) | (55) | (28) |
|---|---|---|---|
| Excavation, 80,300 cu. yd. | $0.50 | $1.08 | $0.80 |
| 12-in. pipe, 1250 ft. | 0.50 | 0.70 | 0.90 |
| 18-in. pipe, 110 ft. | 0.55 | 0.90 | 1.00 |
| 24-in. pipe, 550 ft. | 0.60 | 1.00 | 1.00 |
| 30-in. pipe, 260 ft. | 0.70 | 1.50 | 1.00 |
| 36-in. pipe, 90 ft. | 0.80 | 2.25 | 1.50 |
| Concrete in culverts and monuments, 660 cu. yd. | 10.60 | 16.00 | 12.00 |
| Concrete in pavement, 11,703 cu. yd. | 4.50 | 5.15 | 4.95 |
| Dry-rubble masonry in retaining-walls, 90 cu. yd. | 4.15 | 6.00 | 9.00 |
| Guard-rail, 9650 ft. | 0.40 | 0.55 | 0.50 |
| Monuments, 230 | 0.50 | 1.00 | 1.50 |
| Total | $121,241.63 | $165,748.45 | $138,249.85 |

The State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $107,771. Contract was awarded to W. A. Dontanville for $138,249.85, making a total cost of $246,020.85, or $20,500 per mile.

The following bids were received November 12 for construction of 9 miles of State highway in Nevada county between Rattlesnake creek and the southerly county boundary:

| Item and quantity | (31) | (49) | (19) | (4) |
|---|---|---|---|---|
| Excavation, 85,000 cu. yd. | $0.80 | $0.87 | $0.90 | $1.25 |
| 12-in. pipe, 1508 ft. | 0.70 | 0.70 | 1.00 | 0.90 |
| 18-in. pipe, 704 ft. | 0.80 | 1.00 | 1.10 | 1.00 |
| 24-in. pipe, 360 ft. | 1.00 | 1.50 | 1.15 | 1.25 |
| Concrete in culverts and monuments, 300 cu. yd. | 14.00 | 22.00 | 19.00 | 17.50 |
| Monuments, 248 | 1.00 | 1.50 | 1.50 | 2.00 |
| Total | $85,590.82 | $83,221.60 | $85,268.40 | $114,507.20 |

The State will furnish pipe-railing, corrugated pipe, reinforcing-steel, cement, sand, and coarse aggregate, valued at $5343.90. Contract was awarded to A. J. Fairbanks, Willits, for $83,221.60, or a total of $88,565.50, or $9800 per mile.

An examination of the figures published in this article and the articles appearing in the July and November numbers shows that, omitting one contract calling for re-surfacing only, 133 bids were received from 55 different contracting firms on 36 different pieces of work. On one contract bids were received twice, and rejected both times. The largest number of bidders on any one contract was nine, for grading the highway in Santa Barbara county between Las Cruces and Gaviota pass. On several contracts only one bid was received. In all, 32 contracts, covering 261.36 miles of highway, were awarded. Eight of these contracts, covering 73.7 miles of highway were for grading, culverts, and similar work, and did not include paving, 4 contracts covering 26.5 miles of highway, were for 'finishing-grading' and paving, where the rough grading had been done before, while 20 contracts, covering 159.16 miles of highway, included both grading and paving. The total contract price was $2,302,740.23. The cost of materials furnished by the State will be approximately $1,250,000, making a total of over $3,500,000. To this amount should be added the cost of asphaltic surfacing for the concrete pavement, the State Highway Commission's overhead, and the cost of right-of-way and some large bridges. The total cost of this work will probably be between $4,000,000 and $4,500,000.

A comparison between the engineers' estimate and the bids is of interest. For the first 8 contracts, which were awarded in May, the figure named by the lowest bidder was in each case below the engineers' estimate, the total difference being $40,483.46. After that time, war-conditions appear to have made the contractors more cautious. Of the remaining 24 contracts that were awarded, 9 were for amounts less than the engineers' estimate and 15 were for more than the estimate. For the entire season, the sum of the bidding prices is $21,868.60 more than the engineers' estimate. This does not include jobs on which all bids were rejected.

Classification of excavation appears to have been practically abandoned by the State Highway Commission engineers. On only one contract does any other grading item than excavation without classification appear. In this case there is an item of borrow excavation, presumably hauled for a considerable distance, taking the price named by the low bidder, $0.80 per cubic yard, as a criterion. Excavation without classification is an item of all of the 32 contracts awarded. The lowest price was

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$0.39, the highest $1.05, and the average $0.704 per cubic yard.

Concrete in culverts and monuments, the State furnishing all materials, is an item in 21 contracts. There is a wide range in prices, the lowest being $6, the highest $22, and the average $12.34 per cu. yd. On 8 contracts, the State furnished only the cement. The lowest price is $12, the highest $17.50, and the average $14.94 per cubic yard.

Concrete in pavement, the State furnishing all materials, is an item in 22 contracts. The lowest price is $3.09, the highest $6, and the average $4.19 per cu. yd. On 3 contracts the State furnished only the cement. The average price is $6.43 per cubic yard.

Other bidding prices are as follows: Concrete in retaining-walls, the State furnishing only the cement, are an item in 3 contracts. The average price is $13.33 per cu. yd. Dry-rubble masonry retaining-walls are an item in 4 contracts. The average price is $6 per cu. yd. Ordinary rubble-masonry is an item in 1 contract at $7 per cu. yd. Guard-rail is figured at from $0.40 to $0.50 per foot. Laying corrugated metal pipe is an item in most of the contracts, but the prices quoted are so variable that average figures would mean little or nothing.

Figures taken from an article on State highway work in the September 1915 number of WESTERN ENGINEERING, show the trend of prices during the past two years and a half. They cover low bids on contracts awarded between December 14, 1914, and July 26, 1915.

Excavation without classification was an item in 26 contracts, the lowest price being $0.30, the highest $0.70, and the average $0.50 per cu. yd. Concrete in culverts and monuments, the State furnishing all materials, was an item in 19 contracts. The lowest price was $6, the highest $15, and the average $10.10 per cu. yd. On 9 contracts, where the State furnished only cement, the lowest price was $7.50, the highest $16, and the average $11.05 per cu. yd. Concrete in pavement, the State furnishing all materials, was an item in 15 contracts. The lowest price was $2.20, the highest $4.25, and the average $2.90 per cu. yd. On 5 contracts, where the State furnished only cement, the lowest price was $3.49, the highest $6.15, and the average $4.41 per cubic yard.

In view of the above facts, it may safely be stated that the labor-cost of highway construction has increased at least 40% during the past two and one-half years. Fortunately for the general public, the increase in the cost of materials, while it has been large, has not been so large as the increase in the cost of labor.

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**Spark-plugs** may be prevented from sticking by the use of a thick paste of flake-graphite and oil. The graphite will prevent adhesion of the metals and leakage as well.

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**Gas** from septic tanks is being used to run engines at Paramatta, New South Wales. The engines operate the sewage-pumping plant.

## CANAL-TUNNELS

The first modern tunnel constructed for commercial transportation was the Malpas tunnel on the Languedoc canal in France. It was 515 ft. long, 22 ft. wide, and 27 ft. high, and built between 1679 and 1681 by Riquet. No more canal-tunnels were driven in France for nearly 100 years, the Rive de Gier tunnel, 1656 ft. long, being constructed on the Givors canal in 1770, and the Torcy tunnel, 3970 ft. long, on the Centre canal in 1787. The Tronquoy and the Riqueval tunnels on the St. Quentin canal were started in 1803, and the Noireu tunnel, 39,400 ft. long, on the same canal, was begun in 1822. On the Bourgoyne canal, the St. Aignan tunnel was started in 1824. By the middle of the 19th century nearly 20 canal-tunnels, with a total length of nearly 93,500 ft., had been constructed in France.

The first canal-tunnel in England was the Harecastle tunnel, on the Grand Trunk canal, which was begun in 1766, and opened for traffic in 1777. This was 8640 ft. long, 9 ft. wide, and 12 ft. high. There were originally four other shorter tunnels on this canal. The Harecastle tunnel was replaced in 1824 by a parallel tunnel which was 16 ft. high and 14 ft. wide, 4 ft. 9 in. of which was used for a towpath. The Sapperton tunnel on the Thames-Medway canal was started in 1783. It was 12,500 ft. long, and its construction took six years. The next large canal-tunnel in England was the Blisworth tunnel, 9250 ft. long, on the Grand Junction canal. It was started in 1798, and required seven years for its completion. In 1856 there were over 45 tunnels on the various English canals, with an aggregate length of 220,000 feet.

The first canal-tunnel in the United States was the Auburn on the Schuylkill Navigation canal. It was 450 ft. long, 20 ft. wide, and 18 ft. high, and was begun in 1818, and opened for traffic in 1821. It was made an open cut in 1855-56. The Summit level, or Lebanon tunnel, on the Union canal, was begun in 1824, and finished in 1826. It was originally 720 ft. long, 18 ft. wide, and 15 ft. high. It was followed by the Conemaugh and Grant's Hill tunnels on the western division of the Pennsylvania canal (1827-30); the Pawpaw tunnel, on the Chesapeake and Ohio canal (1836); and two tunnels on the Sandy and Beaver canal, (1836-38).—'Canadian Engineer.'

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**Cement** is being produced by a French firm from the scum formed by boiling beets for sugar-manufacture. The scum consists chiefly of carbonate of lime and water. From 70,000 tons of beets, 4000 tons of carbonate of lime is obtained. To this, 1100 tons of clay is added, the resulting product being 3162 tons of excellent cement. The scum is pumped into large tanks, where it is allowed to dry partly; finely-divided clay is then mixed with it; the mixture is amalgamated thoroughly by beaters for an hour and burned in a rotary kiln, in much the same way as portland cement. The clinker is then removed and pulverized into cement.

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# Failure of the Coyote River Bridge*

On October 20, 1917, the bridge across Coyote river on Santa Clara street at San Jose, California, failed under a freight-train consisting of a motor and three cars. The train-crew escaped uninjured, but a boy who was crossing the bridge on a bicycle was killed.

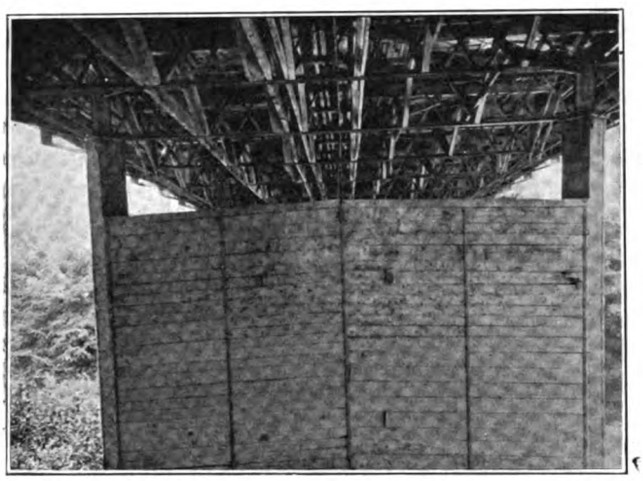

FIG. 1. FLOOR SYSTEM OF BRIDGE

Fortunately no one else was on the bridge at the time, although the accident occurred in the middle of the afternoon and the bridge is on one of the principal streets of the town. The contents of the cars was saved, but the cars themselves were badly damaged, and the bridge is a total loss except for its junk value.

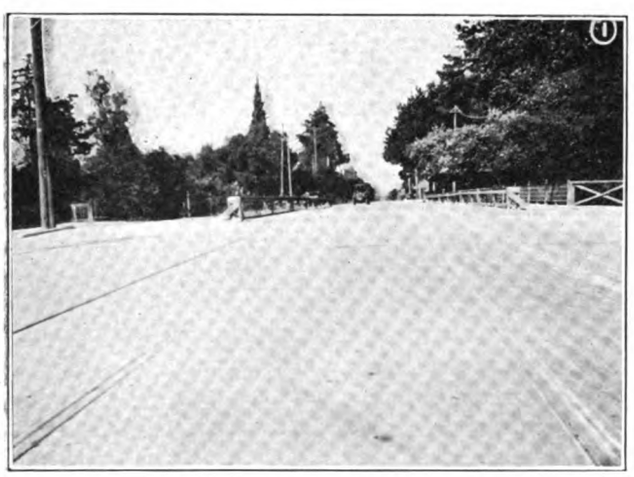

FIG. 2. VIEW OF BRIDGE BEFORE THE FAILURE

As is the case with many other public works in small cities, and some larger ones, the records of the bridge are meagre. The bridge was of wrought-iron and was built in 1877 by the Canton Bridge Co. No plans are on file, but it is probable that the bridge company furnished its own plans and also did the work of erecting. There were three spans, each 53 ft. 4 in., making a total of 160 ft. Four-panel Pratt pony-trusses were used, each panel being 13 ft. 4 in. long. As will be seen from Fig. 1, the construction of the floor-beams was peculiar. Each beam was a complicated and statically indeterminate truss, built up of angles, lattice-bars, and several other kinds of shapes. The sidewalk spaces were on the outside of the trusses, the truss forming a sort of guard-rail between the sidewalk and the roadway. The width of roadway was 30 ft. and the sidewalks 8 ft. each, making a total of 48 ft., including trusses.

FIG. 3. PART OF WRECK OF BRIDGE

Coyote river has a relatively small drainage-area, and, except directly after a heavy rain, the run-off is small, 10 second-feet or less. At the bridge-site the bed of the stream is about 40 ft. below the bridge-floor. The channel of the stream at this point is approximately at right angles to the axis of the bridge.

The bridge was originally designed to carry pedestrian and vehicular traffic only. In the late 'eighties or early 'nineties, a double-track street-railway line was built across the bridge, but the light cars in use at that time could not have increased the stresses in the bridge-members to any considerable extent. The loads on the bridge increased with the passing years, but the practice of hauling heavy freight-cars across it does not appear to have commenced until about 1911. The

*From data furnished by G. Walter Hunt, city engineer, San Jose, California.

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street-railway system had by that time been extended to serve a considerable part of the agricultural district east of the city. A short distance north-east of the bridge a connection between the street railway, or more properly, the interurban railway system and the Southern Pacific railroad was made, and the interurban line became practically a feeder of the steam railroad, as far as freight was concerned. Short trains of standard freight-cars, pulled by an electric motor, were operated across the bridge frequently. It is hard to place the responsibility for this dangerous overloading of the bridge, and the question is relatively unimportant from an engineering standpoint. It was, however, recognized that the old bridge was inadequate and that it needed to be replaced. Tentative plans for a new

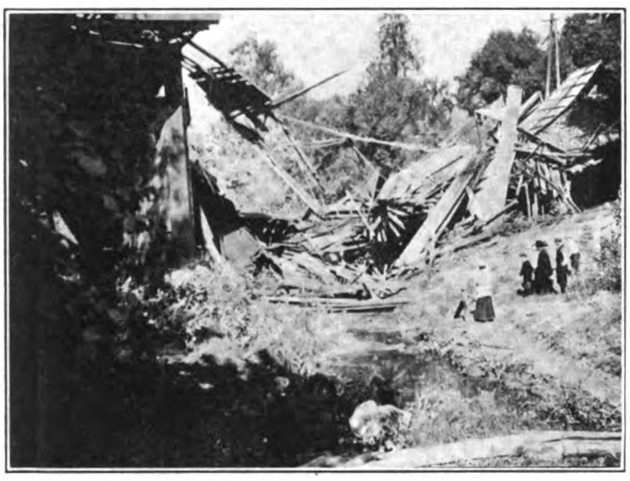

FIG. 4. WRECK OF BRIDGE FROM BELOW

bridge were made about a year ago, but the condition of the steel market prevented anything further being done.

The load on the bridge at the time of the failure was nearly 200 tons, composed of two cars weighing, with their contents, 75 tons each, and one car weighing 45 tons. The exact point of failure cannot be determined, but it is reasonably certain that it was in one of the floor-beams of the middle span. The middle span was completely wrecked and the piers and the other spans nearly so.

Plans for a new bridge at the old site are now under consideration. A single-arch type will probably be chosen. The bridge will have a 54 ft. 6-in. roadway with two 10-ft. sidewalks, and will carry a double-track street-railway line.

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**Defects in castings** may be filled with a paste made of 2 lb. of iron borings, 1¼ lb. of dextrine, and ¾ lb. of litharge, the whole mixture being colored with lampblack to the desired shade. The iron borings should be sifted. After the ingredients are mixed, add enough water to make a paste. This is applied to the defects and blow-holes with a putty-knife. When the paste has dried thoroughly, it can be machined like the metal. —'Mechanical World.'

## GASOLINE CONTENT OF CALIFORNIAN OILS

The data shown in the accompanying table were presented by A. F. L. Bell, chief engineer for the Associated Oil Co. at a recent meeting of the Mineral Resources Committee of the Commonwealth Club of California. The table is based on field-tests of a number of representative Californian oils. It shows that while a light-gravity oil is likely to contain a higher proportion of gasoline than a heavy-gravity oil, there is no direct relation between gravity and proportion of gasoline, either in oils from different fields or in oils from different parts of the same field.

In this respect Californian oils differ from Eastern oils. In most of the Eastern fields, the oils from a particular field all have approximately the same gravity and contain approximately the same proportion of gasoline. This is one of the reasons why it is easier to operate the Eastern pipe-lines on a common-carrier basis than it would be in California.

| | Gasoline content, % | | | | |
|---|---|---|---|---|---|
| Gravity of oil, °B. | Coalinga field | Belridge field | Midway field | Lost Hills field | Santa Maria field |
| 20 | ... | ... | 0.0 | ... | ... |
| 21 | ... | ... | ... | 3.5 | ... |
| 21.5 | ... | ... | 3.4 | ... | ... |
| 22 | ... | ... | 2.4 | ... | ... |
| 23 | ... | ... | 6.8 | ... | ... |
| 24 | ... | ... | 8.6 | 7.66 | ... |
| 24.5 | 3.5 | 8.5 | 8.5 | 5.75 | ... |
| 24.5 | ... | ... | ... | 5.92 | ... |
| 25 | 4.0 | ... | 4.0 | 10.0 | ... |
| 25.5 | ... | 5.86 | 6.0 | ... | 11.0 |
| 25.5 | ... | ... | ... | ... | 8.0 |
| 26 | ... | 14.0 | 4.75 | 7.4 | ... |
| 26 | ... | 9.38 | ... | ... | ... |
| 26 | ... | 13.0 | ... | ... | ... |
| 26.5 | 4.0 | ... | 10.5 | 12.0 | ... |
| 26.5 | ... | ... | 9.5 | ... | ... |
| 27 | ... | 11.27 | 14.0 | 7.22 | ... |
| 27.5 | ... | 10.26 | 9.5 | ... | ... |
| 27.5 | ... | 12.10 | ... | ... | ... |
| 28 | 7.0 | ... | 11.0 | ... | ... |
| 28.5 | 12.0 | ... | 11.5 | 14.0 | ... |
| 28.5 | ... | ... | 14.0 | ... | ... |
| 29 | 12.0 | ... | 14.0 | ... | ... |
| 29 | 7.5 | ... | ... | ... | ... |
| 29.5 | ... | ... | 13.5 | ... | ... |
| 30 | 12.4 | 3.0 | 17.3 | ... | ... |
| 30.5 | ... | ... | 18.0 | ... | ... |
| 30.5 | ... | ... | 17.0 | ... | ... |
| 30.5 | ... | ... | 19.1 | ... | ... |
| 32.5 | ... | ... | ... | 25.0 | ... |
| 34 | ... | 11.0 | ... | ... | ... |
| 34.5 | ... | 9.0 | ... | ... | ... |

---

**To anneal copper,** heat the metal to a red heat and cool it suddenly in cold water. Copper annealed in this way is left soft. Hammering causes it to harden and become springy. For this reason, when working copper so that much bending or hammering is done, the metal should be frequently annealed.—'Mechanical World.

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# Measures for Increasing the Production of Petroleum in California*

By JOHN BARNESON†

Records of the U. S. Geological Survey show that the stocks of crude petroleum in the United States on July 31, 1917, amounted to 166,607,000 bbl. against 189,283,766 bbl. on July 31, 1916, a decrease of 22,676,-766 bbl. The quantity marketed in July 1917 was 29,-344,000 bbl. as compared with 25,379,700 bbl. in July 1916. The quantity of petroleum marketed in the first seven months of 1917 was 12% greater than in the first seven months of 1916. Stocks of crude oil held by the pipe-line companies, marketing agencies, and refiners who receive all or part of their oil direct from wells, increased 3,383,974 bbl. during the first seven months of 1916, but decreased 7,421,000 bbl. in the corresponding period in 1917. The average daily draft on stocks in July 1917 was 47,000 bbl. and the average for the first seven months of the year was 35,000 barrels.

In California the records of the Standard Oil Co. show that the average excess of shipments over production since the first of this year has been about 35,000 bbl. per day. The decline per year in daily production of existing wells is estimated at 20,000 bbl. Therefore, to compensate for the present shortage and for the decline in production of old wells requires a production of 55,000 bbl. per day from new wells to be completed during the coming year.

The average well in California yields 35 bbl. per day. The number of new wells of this size to be completed during the coming year in order to give a production of 55,000 bbl. per day is 1571, or 131 per month. In September 1917, 66 wells were completed, or approximately half the necessary number.

The question is, will it be possible to increase drilling to such an extent that the requisite number of wells can be completed. If an extensive drilling campaign is started it will be three months before enough additional wells are completed to have any effect on production. In June 1917 there were 370 drilling-crews at work in the State, and these crews completed only 55 wells during the month. If 370 crews completed only 55 wells, to complete 131 wells would require 881 crews. With the 370 crews taking the more experienced drillers, it would be impossible to get the necessary men for the 511 additional crews required. The training of a driller requires at least one year. If this drilling campaign should be rushed with inexperienced men, the resultant loss of time and materials would reduce the number of wells completed. For some time to come the labor situation is going to be affected by the draft situation. It is estimated that 32% of the oil-workers of the State are registered for the draft.

The shortage of materials is even more important than the shortage of labor. Prices of well-materials have increased from 25% to 300% since the beginning of the War, the average being about 100%. The most necessary equipment such as boilers, tubes, casing, cable, and gas-engines, is the scarcest. Eight companies control 80% of the wells in the State, and they can contract for material for drilling only 600 wells, less than half the number required.

It is evident from the above considerations that drilling should be done on the land which will give the largest production in the shortest time with the expenditure of the least labor and materials. The most available districts are the Buena Vista Hills, Coalinga, Sunset, Coyote-Merced, and Santa Maria fields. For our purposes we can neglect the Coalinga, Sunset, and Santa Maria fields. The average production of wells in these fields ranges between 47 and 57 bbl. per day. This would require the drilling of a greater number of wells than is practicable, as has been shown already. The Coyote-Merced and Buena Vista Hills are the only fields left.

The Coyote-Merced field contains about 500 acres of proved land. Although many of the wells have a large initial production, the average for the field is 193 bbl. per day per well. To get the 55,000 bbl. of additional production per day by drilling in this field alone would require 285 wells per year, or 24 per month. The average number of wells completed in this field at the present time is 5 per month, or 19 less than the required number. At the rate of 5 wells per month it would take nearly 5 years to complete the required 285 wells. The wells in this field are from 3400 to 4450 ft. deep, and much hard material is encountered. The result is that the wells require a long time to complete. The gas-pressure is small and the wells flow for only a short time after completion, requiring to be pumped after that time.

The total proved area in the Buena Vista Hills is approximately 9000 acres, of which 78% is now in litigation, and 22% or 2000 acres is not in dispute. Wells in this field have an average production of 177 bbl. per day. To obtain the necessary 55,000 bbl. per day would require 310 wells per year or 26 per month. The average number of completions at present is 5 per month, or 21 less than the required number. These wells have a smaller production than in the Coyote-Merced field, but they are much shallower, being from 2100 to 3100 ft. deep. The gas-pressure is high.

*Extract from remarks made at a meeting of the Mineral Resources Committee of the Commonwealth Club of California.

†President, General Petroleum Corporation, San Francisco.

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To obtain the desired production from drilling in the Buena Vista Hills field alone would require only 25 more wells per year than would be required if drilling were done in the Coyote-Merced field alone. The drilling conditions in the Buena Vista Hills are more favorable than they are in the Coyote-Merced field. Transportation facilities are also better for the former field, since besides rail connections, there are pipe-lines running north, west, and south. On the other hand, the transportation facilities in the Coyote-Merced fields are hardly sufficient for the present production. It would be hard to get pipe for new lines. The best place to drill in order to obtain a rapid increase of production is therefore the Buena Vista Hills.

## PULSATIONS IN PIPE-LINES*

By H. C. VENSANO

The conclusions given below are based on a series of experiments on the penstock at the Drum power-house of the Pacific Gas & Electric Co. in Placer county, California. This penstock is 6282 ft. long and has a diameter of 72 in. at the upper end and 52 in. at the power-house. The following nomenclature is used in the formulas:

$a$ = velocity of wave-propagation in a pipe of uniform diameter.

$b$ = thickness of pipe-wall in inches.

$D$ = diameter of pipe in inches.

$E$ = coefficient of elasticity of steel, taken as 30,000,000 lb. per square inch.

$g$ = acceleration from gravity in feet per second.

$h$ = pressure rise or fall from normal, resulting from pulsations, measured in feet of head at any point.

$K$ = voluminal modulus of elasticity of water, taken as 294,000 lb. per square inch.

$L_1$, etc. = length in feet of sections of pipe of varying diameter, between the point at which the pressure is desired and the reservoir, $L$ being the first section, starting at the point at which the pressure is desired.

$T$ = time of gate-closure or gate-opening, in seconds.

$V_1$, etc. = velocity of flow in feet per second at beginning of gate-motion.

$v_1$, etc. = velocity of flow in feet per second at end of gate-motion.

$W$ = weight of water per cubic foot, taken as 62.4 pounds.

1. The general formula for pressure-variation from normal at any point in a pipe-line, with uniformly varying gate-opening, should be

$$h = \frac{2(L_1 V_1 + L_2 V_2 + \ldots L_{x-1} V_{x-1} + L_x V_x)}{g\ T}$$

This formula applies to a pipe with varying diameter.

2. For slow gate-closure, this formula reduces to

$$h = \frac{2(L_1 V_1 + L_2 V_2 + L_3 V_3 +, \text{etc., for the full length of pipe})}{g\ T}$$

and, further, reduces to

$$h = \frac{2L_1 V_1}{g\ T}$$

for slow gate-closure with a pipe of uniform diameter. The above formulas are limited to a maximum value of

$$h = \frac{a_1 v_1}{g}$$

3. As this formula indicates, the velocity of flow at the gate, or at the point where the pressure is to be ascertained, does not necessarily (of itself alone) fix the magnitude of the pressure-wave at such point, but the magnitude of the pressure-wave is influenced by the varying velocities of the moving water-column in all portions of the line between the point at which the pressure is to be ascertained and the reservoir.

4. Under ordinary conditions, the water-hammer effect may, and does, produce as great a fall in pressure below the normal as it produces a rise above normal after the gate has been closed completely. In other words, the pressure vibrates back and forth above and below normal after gate-closure.

5. In pipes of uniform diameter, the magnitude of pressure variation along the pipe-line will vary directly as the time required for the wave to travel from any point in question to the reservoir and return to the same point, provided the time of gate-closure is greater than the half-period of the pipe.

6. The effect of accelerating the water-column by gate-opening is analogous to the effect of retardation in gate-closing, except that the pressure-variations have the opposite sign. The period of pulsation is the same. The chief difference is that the wave-effects die out more rapidly with opening than with closing. This seems to affect the vibration so that the full magnitude is obtained only for a short time.

7. The velocity of wave-propagation in water, for riveted-steel pipe, can be calculated approximately by the recognized formula:

$$a = \frac{12}{\sqrt{\frac{W}{g}\left(\frac{1}{K} + \frac{D}{E\,b}\right)}}$$

if proper allowance is made for the effect of joint-details.

*Abstract from 'Proceedings' of the American Society of Civil Engineers, October 1917, page 1593.

**Waste heat** from the jacket-water of a gas-engine may be utilized by a method described by J. B. Meriam in 'Practical Engineer.' A small centrifugal pump is used to circulate water at high velocity through the jacket, into an adjoining closed tank, which is kept about half-full of water, and back to the jacket. Steam escapes at the water-level. A gauge-pressure of about 25 lb. is maintained. All the heat that the engine gives to the jacket-water, estimated at 38% of the heat in the fuel, is found in the steam. With a well-designed exhaust-gas boiler, half of the 38% of the heat in the fuel lost in the exhaust-gas could be recovered and added to that recovered from the water-jacket. The high speed of the water through the jacket sweeps away steam bubbles that may form on its surface. This prevents overheating the cylinder, which usually comes from having too high a temperature of the jacket-water.

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# Evaporation From Water-Surfaces and River-Bed Materials*

By R. B. SLEIGHT†

The experiments described below were made at the Irrigation Field Laboratory at Denver, Colorado. The work was commenced in 1915 and continued for over one year.

The first series of experiments was to determine the difference in rates of evaporation from tanks of varying diameters. Thin-metal circular tanks were used, set in the ground so that the top of the tank was 3 in. or less above the ground-surface. Taking the rate of evaporation from a tank 12 ft. diam. as 100, the rates of evaporation from smaller tanks were found to be as follows: 1-ft. tank, 155; 2-ft. tank, 129; 4-ft. tank, 118; 6-ft. tank, 110; 9-ft. tank, 101.

The second series of experiments dealt with the relative evaporation from square and from circular tanks. The rate of evaporation from square tanks was found to be from 103 to 105% of that from circular tanks of the same area.

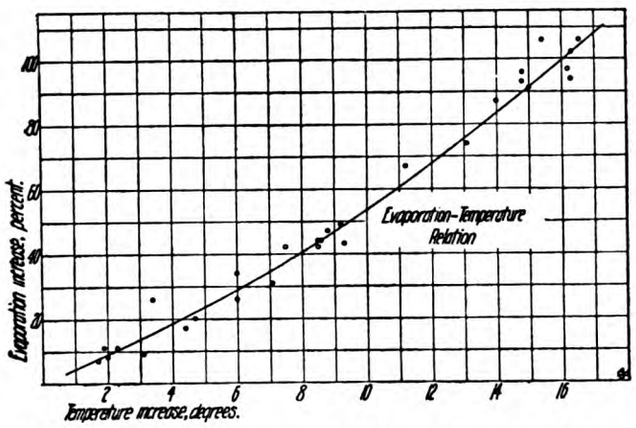


FIG. 1. RELATION BETWEEN TEMPERATURE AND EVAPORATION

Experiments to determine the effect of depth of water in the tanks upon the rate of evaporation showed greater evaporation in summer from shallow tanks than from deep tanks, and that the reverse was the case in the fall. This difference was relatively small for tanks more than 2 ft. deep.

The relative rates of evaporation from still and from flowing water were studied by keeping the water in one tank flowing by means of a centrifugal pump, another tank of still water being kept under conditions that were similar in other respects. After correcting the results for differences of temperature, the rate of evaporation from the flowing water was found to be about 8% greater than from the still water. The surface-velocity of the flowing water was from 0.52 to 1.25 ft. per sec. No definite relation between rate of evaporation and velocity could be established.

Fig. 1 shows the results of the experiments to determine the effect of temperature upon evaporation. Temperatures are given in degrees Fahrenheit. The temperature given is that of the water-surface, and was taken by means of floating thermometers. In this connection temperature-readings of the air and the water at different depths are of interest. On a warm day in March, the air-temperature was 69°, while the water-temperature at the surface was 59°, and at a depth of 2.5 ft., 46.5°. On a cold day in May the air-temperature was 45°, but the temperature of the water had increased to 56° at all depths. During the summer in the daytime the water was considerably cooler than the air, while readings in the latter part of September showed an air-temperature of 56° and a water-temperature at the surface of 56.5° and at 2.5 ft. of 58°.

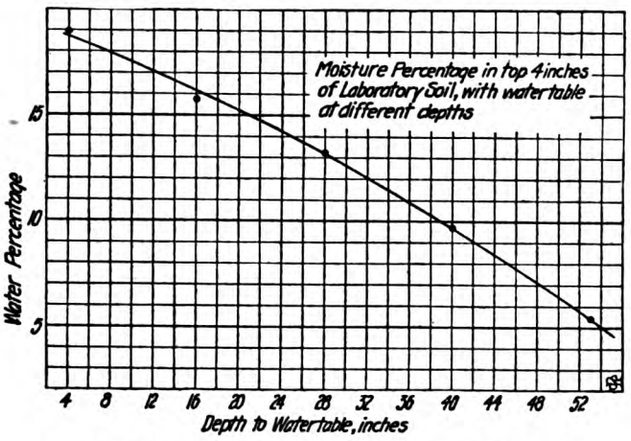
Moisture Percentage in top 4 inches of Laboratory Soil, with water table at different depths
Water Percentage
Depth to Water table, inches

FIG. 3. RELATION BETWEEN DEPTH TO WATER-TABLE AND MOISTURE IN TOP-SOIL

Comparisons were made between the U. S. Weather Bureau standard evaporation-pan, which is 4 ft. diam., 10 in. deep, and is set on a wooden platform resting on a low mound, and the 12-ft. tank set in the ground 2.75 ft. as already described. Readings taken during a period of one year, showed that the rate of evaporation from the pan ranged from 131 to 178% of that from the tank, with an average of 150%.

Experiments with the Piche evaporimeter showed that this instrument was relatively unreliable. Individual readings varied as much as 42% from the mean computed from comparison with the 12-ft. tank.

A U. S. Geological Survey standard floating-tank, 3 ft. diam. and 3 ft. deep, was placed on an artificial

*Abstract from 'Journal of Agricultural Research,' Vol. X, No. 5, pp. 209-261.

†Assistant irrigation engineer, U. S. Office of Public Roads and Rural Engineering.

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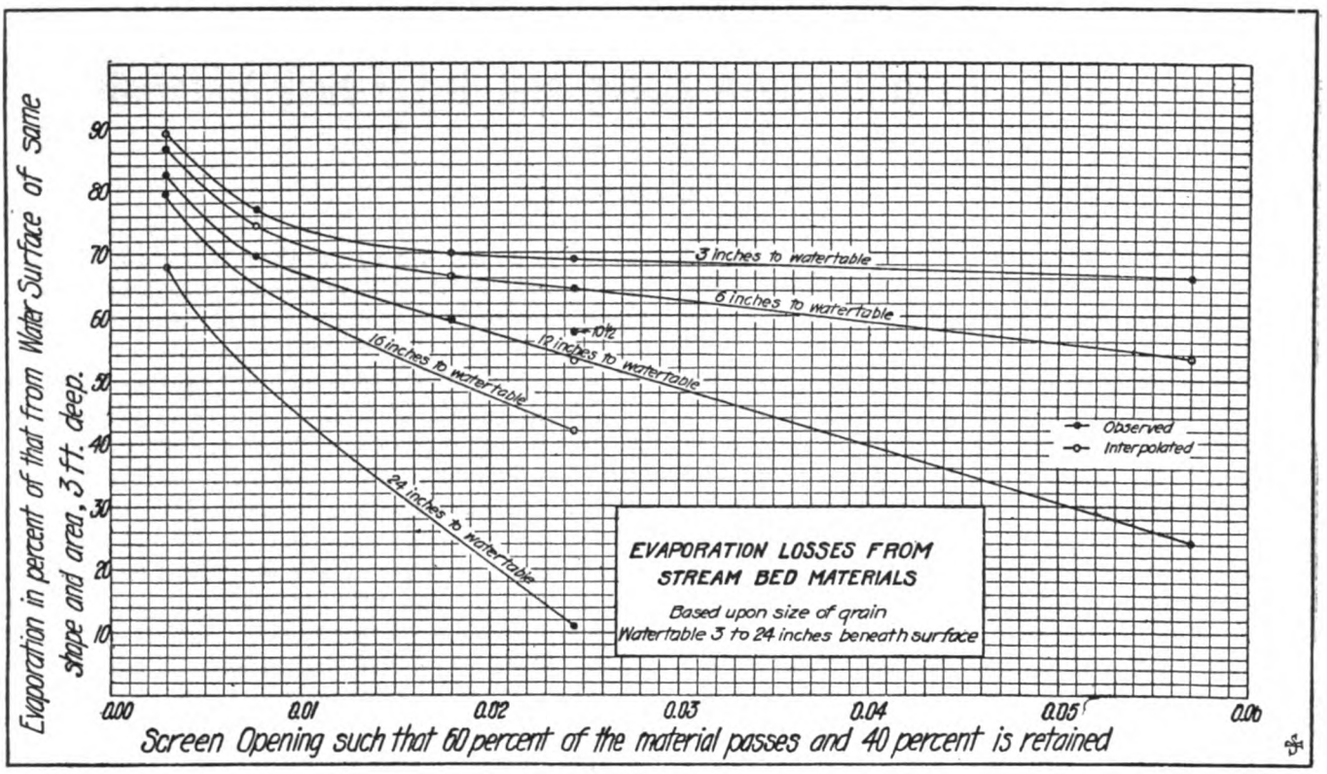


FIG. 2. EVAPORATION LOSSES FROM STREAM-BED MATERIAL

lake about 3400 ft. from the laboratory. The same general atmospheric and other conditions existed in both places. The area of the lake was 17 acres. From the data obtained the following rules were deduced:

1. Evaporation data from tanks 2 ft. or greater in depth, preferably circular, set in the ground so that a metal rim not over 3 in. wide is all that projects above the surface, and in which tanks the water is kept approximately at the ground-level, are most applicable for extension to large open-water surfaces.

2. Data on such tanks may be extended to large open-water surfaces that are under the same conditions of wind, air-temperature, and relative humidity by multiplying the evaporation-depth from a

Tank 2 ft. diam. by 0.77
Tank 4 ft. diam. by 0.84
Tank 6 ft. diam. by 0.90
Tank 9 ft. diam. by 0.98
Tank 12 ft. diam. by 0.99

The second part of the investigation related to the rate of evaporation from stream-beds when no water flows on the surface. Samples were taken of sand and gravel from stream-beds in different Western States. These were placed in tanks in which the water-table was kept at a given distance from the surface, and the rate of evaporation determined. The relation between these rates of evaporation and the rate from a water surface under similar conditions is shown in Fig. 2.

Similar experiments were made using the soil at the laboratory-site in place of river sand and gravel. The mechanical analysis of this soil was as follows: Fine gravel, diam. 1 to 2 mm., 2.3%; coarse sand, 0.5 to 1 mm., 6.2%; medium sand, 0.25 to 0.5 mm., 4.5%; fine sand, 0.1 to 0.25 mm., 34.8%; very fine sand, 0.05 to 0.1 mm., 20.5%; silt, 0.005 to 0.05 mm., 15.8%; clay, less than 0.005 mm. diam., 15.8%. Taking the rate of evaporation from a tank 2 ft. diam. with the water 2.75 ft. deep as 100, the corresponding rates for the soil for different distances of the water-table from the ground-surfaces was as follows: 4 in., 88.2; 16 in., 79.8; 28 in., 62.4; 38 in., 33; 43 in., 7.63; 50.5 in., 7.24. No explanation is given for the break between the 38-in. and the 43-in. depth. Fig. 3 shows the relation between the depth to the water-table and the proportion of moisture in the top 4 in. of the laboratory-soil.

---

**Railroad construction** at night is made feasible by the use of a lighting-plant mounted on a freight-car. Projecting from a tower built at one end of the car is a light-arm that extends over the track. At the end of this arm two searchlights are placed, while other lamps are placed at intervals along the arm. By this means light can be shed upon the part of the track below the arm, while beams of the search-lights can be cast ahead where the work of preparing the road-bed is under way. The lighting-plant permits carrying on work in tropical countries in the cool hours while the sun is below the horizon.

---

**Gauge-glasses** may be cleaned by soaking them in the following solution: Water, 6 oz.; common salt, 1 oz.; acetic acid, 1 oz. When the glass is moistened thoroughly some baking-powder is placed inside. The glass is then put back in the solution. The tube can afterward be wiped with a cloth.—'Mechanical World.'

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# Cost of Highway Construction Near Globe

The following summary of the cost of construction of the 'Copper Hill' road in Gila county, Arizona, is taken from the 'Arizona Record.' The road was of water-bound macadam 16 ft. wide. The work was under the direction of county engineer Thomas.

1. Camp

| | |
|---|---|
| Labor | $174.94 |
| Material | 81.62 |
| Superintendence | 12.85 |
| Total | $269.41 |

This cost includes the moving of camp purchased from the State of Arizona from Section 2 of the Globe-San Carlos highway to Copper Hill.

2. Clearing and grubbing

| | |
|---|---|
| Labor | $12.10 |
| Material | 0.50 |
| Total | $12.60 |

3. Excavation and borrow

Loose rock and earth excavation:

| | |
|---|---|
| Labor | $3,781.14 |
| Team hire | 67.89 |
| Equipment rental | 5.25 |
| Material | 80.16 |
| Equipment depreciation | 50.00 |
| Explosives | 41.25 |
| Superintendence | 47.23 |
| Total | $4,072.92 |
| Cubic yards | 5,267.40 |
| Cost per cubic yard | $0.746 |

Solid rock excavation:

| | |
|---|---|
| Labor | $1,060.82 |
| Material | 17.95 |
| Explosives | 119.70 |
| Superintendence | 43.00 |
| Equipment depreciation | 20.00 |
| Total | $1,261.47 |
| Cubic yards | 966.30 |
| Cost per cubic yard | $1.306 |

Borrow (earth and loose rock):

| | |
|---|---|
| Labor | $181.75 |
| Team hire | 144.83 |
| Equipment rental | 10.50 |
| Equipment depreciation | 10.00 |
| Superintendence | 10.00 |
| Total | $357.08 |
| Cubic yards | 1,157.40 |
| Cost per cubic yard | $0.309 |

4. Concrete bridges and culverts

Average haul for sand and gravel, 3 miles

| | |
|---|---|
| Foundation excavation | $77.25 |
| Labor on forms | 80.99 |
| Material for forms | 86.53 |
| Hauling sand and gravel | 506.20 |
| Cement, cost | 330.50 |
| Cement, hauling | 22.00 |
| Rental of mixer | 25.00 |
| Mixing and placing | 257.50 |
| Superintendence | 53.35 |
| Total | $1,439.32 |
| Cubic yards | 139.00 |
| Cost per cubic yard | $10.354 |

Reinforcement and guard-rail:

| | |
|---|---|
| Cost of reinforcement, 3292 lb. | $123.52 |
| Bending | 31.09 |
| Cost of guard-rail | 32.74 |
| Total | $187.35 |

5. Corrugated-iron pipe

| | |
|---|---|
| Cost | $580.30 |
| Placing | 17.50 |
| Total | $597.80 |

6. Dry-wall (masonry facing)

| | |
|---|---|
| Labor | $252.90 |
| Material | 10.00 |
| Superintendence | 20.63 |
| Total | 283.53 |
| Cubic yards | 158.00 |
| Cost per cubic yard | $1.795 |

7. Ditching

| | |
|---|---|
| Labor | $254.54 |
| Material | 3.00 |
| Superintendence | 30.00 |
| Total | $287.54 |
| Lineal feet | 2,594.00 |
| Cost per lineal foot | $0.111 |

8. Ballast

Loading:

| | |
|---|---|
| Labor | $562.15 |
| Material | 10.00 |
| Superintendence | 10.50 |
| Total | $582.65 |

Hauling:

| | |
|---|---|
| Labor | $187.17 |
| Equipment | 25.50 |
| Teams | 249.27 |
| Superintendence | 10.00 |
| Total | $471.94 |

Spreading:

| | |
|---|---|
| Labor | $91.44 |
| Teams | 40.24 |
| Superintendence | 10.00 |
| Total | $141.68 |
| Royalty | $100.00 |
| Total cost | $1,296.27 |
| Cubic yards | 2,757.40 |
| Cost per cubic yard | $0.469 |

9. Engineering

| | |
|---|---|
| Engineering and supervision | $377.00 |
| Stakes | 25.00 |
| Timekeeper and cost-keeping | 242.50 |
| Total | $644.50 |

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RECAPITULATION

| | Total cost | % |
|---|---|---|
| Camp | $ 269.41 | 2.51 |
| Clearing | 12.60 | 0.12 |
| Excavation | 5,334.39 | 49.80 |
| Borrow | 357.08 | 3.33 |
| Concrete bridge and culvert | 1,439.32 | 13.45 |
| Reinforcement and guard-rail | 187.35 | 1.79 |
| Corrugated pipe | 597.80 | 5.57 |
| Masonry walls | 283.53 | 2.65 |
| Ditching | 287.54 | 2.69 |
| Surfacing | 1,196.27 | 11.17 |
| Royalty on ballast | 100.00 | 0.93 |
| Engineering | 644.50 | 5.99 |
| Total | $10,709.79 | 100.00 |

## STONE-CRUSHERS ON HIGHWAY WORK*

By JOHN H. GORDON†

Jaw-crushers are preferred on highway work. The size favored is the one with the jaw-opening 10 by 20 in. or 12 by 20 in., the latter being the largest size that is portable. There are some crushers in use with a considerably larger jaw-opening. These are mounted on skids and are adapted for use where a considerable quantity of stone is to be crushed at one place. The gyratory crusher as at present constructed is suitable only for a stationary plant.

The size of the boiler and engine to be used is important; a 30 to 35 hp. combination is to be recommended, although many smaller are in use. The 50-ton portable bins may be used to advantage where the output is to be approximately 3000 cu. yd. For a larger output the 100-ton stationary bin will more than repay the additional cost, by providing storage capacity and facilitating the progress of the work. The capacity of the 10 by 20 or 12 by 20 in. crushers is about 125 tons in 10 hours, but this depends largely on the operator. The nature of the stone to be crushed is also a factor. The number of revolutions should not be less than 280 to 290 per minute. A speed-indicator should be used. The use of one jaw of manganese steel will prove a saving.

The selection of the site for the crusher at a stationary plant and its erection are important. The crusher itself should be set on concrete so as to reduce the vibration as much as possible. It should be placed as near the quarry or source of supply as is safe, and the approaches should be graded so as to facilitate hauling the largest load to the platform. Constant lubrication of all parts of the crusher, screen, elevator, etc., is necessary. The bin for tailing should be placed on the end and at right angles to the supply-bins so as to have as little interference as possible with the teams or trucks in loading. These details are often overlooked. The additional cost when they are neglected may run into thousands of dollars on one road alone.

*From the Proceedings of the American Road Builders' Association.

†Contractor, Albany, New York.

## TRAFFIC CAPACITY OF GRAVEL HIGHWAYS

The capacity of unsurfaced gravel highways for carrying traffic was among the subjects discussed at the convention of the American Road Builders' Association held last winter at Boston. R. L. Morrison, professor of highway engineering at the Agricultural and Mechanical College of Texas, was of the opinion that a gravel road carrying more than 150 motor vehicles per day should have a bituminous surface. On the other hand, F. E. Everett, State highway commissioner of New Hampshire, gave instances of unsurfaced gravel highways in his State that carried 800 to 1100 motor vehicles per day during the summer. These roads were maintained in good condition by the patrol system at an average cost of $260 per mile per year.

A. C. Innis, supervisor of repairs for the Connecticut State Highway Commission, told of roads in his State that carried as many as 25,000 vehicles per week. These roads were maintained by the patrol system. One patrolman with three helpers takes care of 11 miles of road, 7 miles of which is gravel. As soon as road conditions are suitable in the spring, 2 lb. of calcium chloride per square yard of road surface is applied. The road is patrolled daily, a drum of calcium chloride and some gravel being carried on the patrolman's wagon. Gravel is also piled at convenient places along the road. Wherever there is a slight depression, gravel and calcium chloride is sprinkled. The cost of maintenance using this system was not given.

In Maine, on the State highway between Portsmouth, New Hampshire, and Portland, there is 20 miles of gravel road with a bituminous surface. The average motor-vehicle traffic in the summer is 2000 per day, and it has been as much as 3500 per day. This highway is treated with tarvia B once a year, 0.6 gal. per square yard being used. The cost of maintenance is about $600 per mile per year, including patrolling.

## PROPERTIES OF ICE

The following data regarding the properties of ice are taken from a paper presented before the Royal Society of Canada, by H. T. Barnes, J. W. Hayward, and Norman M. McLeod:

1. The crushing strength of ice is 400 lb. per square inch.

2. An ice block will yield under pressure at approximately 200 lb. per square inch, probably because of slipping of the crystals.

3. An ice sheet will form cracks on the upper and under surface because of unequal strain.

4. Permanent expansion may result if the cracks become filled and frozen.

5. According to the most trustworthy results obtained by other observers, ice that is frozen to concrete develops its full crushing strength. The tensile strength of ice is less than 200 lb. per square inch.

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# Specifications for Military Motor-Trucks*

Two models are being made, class A, rated to carry 1½ tons, and class B rated to carry 3 tons. After preliminary designs had been laid out for both class A and class B engines, it was found that a consistent design of the latter would be only 120 lb. heavier than the design suggested for the former engine. It was therefore decided to standardize one model for use on both sizes of military truck, the only difference in the two engines being in the bore. The result is a reduction in the number of engine parts. The effect of this is shown in the crank-shaft bearings, of which there are only two sizes on each engine, whereas there are four in the average model. The standardization of parts has gone so far as to use the same bearing five times in connection with the timing-gears.

The fuel-tank is on the dash, with provision for a surplus under the seat. The radiator and fan designs are based on tests made in a laboratory installed by the Quartermaster Department.

It was found that the amount of oil passing per unit of time is the determining factor in the design of the lubricating system. This amount is practically the same in a number of systems operating at widely different pressures. It has been decided to adopt the full-pressure feed with a relief-valve at the end of the system. The capacity is about four times the normal requirements, so that if one bearing takes an excessive amount of oil, the supply will still be sufficient to lubricate the others. The oil is cleaned by passing it through a large screen and through three settling-chambers.

The intake and exhaust manifolds of the engine are designed so that heavy gasoline will be thoroughly vaporized. In fact, it is said that the engines could be operated on kerosene with only minor changes in manifold design.

The governor is driven from the generator-shaft at 1⅓ times engine speed, and is on the side of the engine in line with the intake-manifold, thus permitting the shortest possible throttle-valve connection. A new design of centrifugal-type governor has been developed.

A four-speed transmission of the horizontal-type, placed in the middle of the truck, is used. The first-speed gear-ratio for the class B transmission is 5.93 to 1, and for the class A, 5.28 to 1, the gear ratios on reverse being the same as on first. This gives a total reduction on low gear through transmission and final drive of 56.3 for the class B and 45.9 for the class A trucks.

The counter-shaft is in a horizontal plane with the main shaft, so that the gears of both will operate in oil. The case extends only 5⅝ in. below the centre of the main shaft. An idler-gear is placed above the main shaft and counter-shaft and is lubricated by oil thrown upward from the two shafts. The gear-shift lever is of the ball-end type. There is no rocking-arm for reverse, so that the shifting-mechanism is as simple as that used for three-speed transmissions. The control is from the top. The first and second, and the third and fourth shifter-forks are alike. The reverse-fork is attached to the adjacent rod.

The shifter-forks are fastened to the shifter-rods by means of hardened cone-pointed screws, the cone having a special angle. This construction is used so that the forks can be replaced without any adjustment being required.

The gears and shafts are of alloy steel. Annular bearings are used except on the reverse shaft, where plain bearings will be specified. The front of the transmission is supported by a 6-in. finished trunnion, which is slidably mounted in a ring, the latter in turn being supported in a spherical seat held in a frame cross-member. The main drive-gear has a 1½-in. Society of Automotive Engineers standard taper and the main drive-shaft a 1¾-in. taper.

Four universal joints are used in the drive, two between the clutch and transmission and two between the transmission and rear axle. In some cases a power take-off mechanism will be required on the trucks and therefore provision has been made for a 1⅛-in. Society of Automotive Engineers taper on the extended counter-shaft. Special care has been taken in designing the transmission to secure maximum accessibility and ease of replacement.

The clutch is of the gear-tooth multiple-disc construction. The driving-plates are faced with asbestos, there being nine faces on the driving-disks and nine steel driven-disks. The three springs are not adjustable. These are designed so that the difference in their strength in extension or compression is slight.

The clutch-housing is attached to the fly-wheel housing of the engine. The throw-out bearing is of the 100% thrust type, mounted in the housing and with provision for oiling from the outside of the clutch-face. The throw-out mechanism is of the universal-joint type. This is used so that the pressure around the thrust-bearing will be uniform. The control-mechanism is mounted on the clutch-case. The clutch-gear is of the internal type.

The trucks have two independent ignition-systems, with two separate sets of spark-plugs. The ignition will be controlled by one switch so that both ignition-systems are either in the 'on' or 'off' position. The ignition-distributor is driven from the pump-shaft and has a coil mounted on a pad-side of the distributor. The magneto is also driven from the pump-shaft. The generator is of the third-brush type, giving normally 8 amperes at 750 r.p.m. It is driven by an Oldham coupling and is mount-

*Abstract from the 'Journal' of the Society of Automotive Engineers.

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ed on a pilot on the right-hand side of the engine.

The rear axle on the class B truck is of the worm-gear type, on account of the great manufacturing capacity available for producing the size of axle necessary for the heavy service. The class A truck is equipped with an internal-gear axle.

The worm-gear axle has been simplified. For instance, only two sizes of roller-bearings are used, instead of the five ordinarily required for the full-floating type of axle. The axle-shafts are large in order to take the heavy engine-torque. The dry plate at the end of the axle is held by bolts instead of studs, as is the usual practice.

Two sets of equalized brakes is mounted side-by-side on the rear wheels. As far as possible, all parts for the axles and brake mechanism will be forgings or stampings, instead of castings. With the exception of the brake-anchor, all right and left-handed features have been eliminated so that levers and other parts are interchangeable.

The bolts for adjusting the brake-bands are made with mushroom heads of radius equal to that of the band, so that the bands can be adjusted easily and quickly.

The front axles are of the straight Elliott type of I-beam section. An oil-reservoir in the bottom of the steering-knuckle pivot has capacity sufficient to supply oil to all the pivot-bearings. No grease-cups are used on the front axles.

The rear springs take both drive and torque. The second leaf of each spring is wrapped over the spring-eye to secure increased strength. The frame is of pressed steel, 8 in. deep and with 3-in flanges. The wheel-base for the class B truck is 160 in., giving a turning circle of 5 ft. The maximum steering-angle of 34½° is determined by providing a stop on the steering knuckles. The gage is 64½ in. for both front and rear wheels. Pressed-on tires are used, 5 by 36 in. on the front and 10 by 36 in. on the rear wheels.

The steering-gear is of the worm-and-wheel type. The stearing-gear column is arranged at such an angle that the gear can be taken out and replaced quickly. All the steering connections are back of the front axle.

## USE OF CONCRETE FOR PREVENTING VIBRATION IN COTTON-MILLS

In buildings in which there is reciprocating machinery, such as looms, the moving parts of which have a uniform speed, concrete construction is preferable because a concrete floor absorbs this vibration better than any other type of construction. Aside from freedom from damage to the building the increase of stability and free-running qualities of the machines themselves is an advantage. This adds to the life of the equipment and reduces breakage of threads. It has been found by some manufacturers that looms can be run 15% faster on a concrete than on a wooden floor. It has also been found that, because of the rigidity of the floor, there is a saving in power.—L. C. Wason, in 'Concrete-Cement Age.'

## EFFECT OF STORAGE UPON THE PROPERTIES OF COAL

The results of two independent investigations upon the effect of storing coal have recently been published.

Bulletin No. 136 of the U. S. Bureau of Mines, by Horace C. Porter and F. K. Ovitz describes tests on several kinds of Eastern bituminous coal and on a sub-bituminous coal from Sheridan, Wyoming. The maximum loss in heating value for the Eastern coals stored in the air was 1.2% in one year and 2.1% in two years. The loss for coal stored under water was much smaller, from 0.2% to 0.6%. The Sheridan coal stored in air lost from 2 to 3% of its heating value during the first year and 5.5% in two years.

Experiments on several Illinois coals are discussed in Bulletin No. 97 of the Engineering Experiment Station of the University of Illinois on 'Effects of Storage upon the Properties of Coal,' by S. W. Parr. The following conclusions are given:

(1) Bituminous coal can be stocked without appreciable loss of heat-values provided the temperature is not allowed to rise above 180°F. In fact, there is no appreciable evolution of $CO_2$ at temperatures below 260° Farenheit.

(2) The indicated heat-loss per pound of coal is more likely to be the result of an increase in weight of a unit-mass of coal caused by the absorption of oxygen than of an actual loss of heat-units.

(3) Freshly-mined coal has a large capacity for absorbing oxygen, which combines chemically with both the organic combustible and the iron pyrites present.

(4) The combination of oxygen with coal at ordinary temperatures generates a small increment of heat.

(5) The rapidity with which oxygen is absorbed depends upon the temperature of the mass and the extent of the superficial area exposed, that is, the fineness of division of the coal.

(6) If heat is generated by this slow process of oxidation more rapidly than it is lost by radiation, the acceleration of the reaction causes a rise in temperature which quickly brings the mass up to the danger-point. A temperature of 180° F. is named as the danger-point because, if the coal reaches this temperature, practically all of the free moisture is vaporized and the further rise in temperature will be rapid.

(7) To be successful any method of storage must either check or prevent the absorption of oxygen to such an extent that the generation of heat shall not proceed so rapidly as to exceed natural heat-losses resulting from radiation.

(8) Under-water storage prevents loss of heat-values, and is not accompanied by deterioration in physical properties.

(9) Dry storage is undertaken far more safely if the fine material is removed by screening at the storage-yard and the lump material only, preferably sized, is stocked.

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# Motor Gasoline

By W. W. HANSCOM*

During the past two and one-half years the gravity of the gasoline sold in California has gradually dropped from 62° to 55° B. while the price has increased from 10c. to 20c. per gallon. Replies to questions asked of those familiar with the subject failed to convey any information of a satisfactory nature. No one could say just where the dividing line between gasoline and the heavier liquids should be placed, and the conclusion was that it was a purely imaginary one capable of being shifted whenever the exigencies of the situation required.

In March 1904, the California State Mining Bureau issued Bulletin No. 32 entitled 'Production and Use of Petroleum in California.' On page 187 the following gravities then prevailing for refined products are given as follows:

| | Deg. B. |
|---|---|
| Gasoline | 68 |
| Benzine | 62 |
| Engine-distillate | 56–40 |
| Kerosene | 44–42 |

Practically all of the gasoline now sold at service-stations ranges from 55° to 57° B., which places it in the old engine-distillate class as far as gravity is concerned. Two years ago a mixture of half gasoline and half distillate would have had a gravity of 55°, practically the gravity of the present-day gasoline.

Occasionally articles are published in the daily press calling attention to the importance of the boiling-points of gasoline in the determination of its quality. However, no explanation has been given as to the meaning of the boiling-points and the layman is left without any real information. The ordinary test of the specific gravity of a gasoline will give no real indication as to its suitability as a motor fuel. Most, or in fact, all of the gasolines tested were composed of mixtures, varying in their proportions, of liquids having different boiling-points or temperatures of volatilization. It is the proportions of these different liquids that really determine the efficiency of the mixture.

The boiling-point really means the temperature at which a liquid will be converted into a vapor and driven from the main body. The parts of a liquid having different boiling-points may be separated easily from one another by placing the liquid in a suitable vessel, gradually raising the temperature and condensing the different vapors as they are distilled. This method, called fractional distillation, gives an excellent indication of the quality of gasoline and is used in the laboratory for the purpose of comparing different samples.

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The most important requirement is that the proportions of the liquids having different boiling-points should be so related as to produce a fairly uniform gradation between the highest and lowest boiling-points. It is possible to take two liquids having boiling-points of 122° and 350° F. respectively, mix them in the proper proportions, and obtain a mixture having a gravity of 55°B. Such a mixture would be quite unsatisfactory for commercial use on account of the large proportion of highly volatile liquid, which would render it dangerous to store and handle, and would also result in large evaporation losses from the tank during warm weather or long runs. Most gasoline-tanks on automobiles are placed where the heat from the engine will raise their temperature, and this results in a loss by evaporation.

The proportion of the more volatile liquid should be sufficient to insure easy and rapid starting of a cold engine, and the complete ignition of the heavier and less volatile parts of the gasoline when mixed with the proper proportion of air. A gasoline having 15% of a liquid which would volatilize at 170°F. or less, the remainder being composed of liquids having uniformly increasing boiling-points, has proved satisfactory. Such a gasoline will stand mixing with an equal quantity of 48° distillate without causing inconvenience during starting, except during the winter months, at which time it is advisable to prime the cylinders with gasoline to save wear on the starting-battery. During the summer months I have used straight distillate with perfect success and with increased mileage over that obtained with straight gasoline, without any change in the adjustments except to feed a little more air to insure complete combustion.

When using a mixture of gasoline and distillate, a cold morning will require about ten times as many revolutions of the engine before firing regularly as will straight gasoline, say, 20 revolutions in place of 2. Various proportions of gasoline and distillate may be used with success, depending upon the temperature of the air and the length of run; in fact many automobilists use straight distillate with satisfactory results, putting up with the slight inconvenience during starting because of the fact that fuel costs are nearly halved.

It has been claimed that gasolines having a fairly wide range of boiling-points, say, between 160° and 310° F., uniformly distributed, will give better and smoother action in the engine than those having a narrow range at the lower temperatures. This claim is based upon the assumption that instead of an explosion taking place all at once, there would be a series of explosions following one another in rapid succession and resulting in a

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more uniform pressure on the piston. While the statement appears reasonable, it has not been proved definitely.

An automobile engine is sensitive to adjustments affecting the supply of fuel and air, a slight change making a difference of from 25 to 50% in the number of miles run per gallon. Changes of the carbureter adjusting-screws should be made in fractions of a turn at a time, leaving the engine running at a particular adjustment until conditions become fixed and noted before another change is made. I have seen adjustments made several turns at a time instead of fractions of a turn, and the driver wondered why his machine made only 10 or 12 miles per gallon.

High-gravity gasolines have the low boiling-points and the reverse is true, although the boiling-point is not constant for any given gravity, but varies with the base from which the gasoline is distilled. Eastern gasolines require a higher temperature to vaporize than do those from California having the same gravity. A Californian product of, say, 68° gravity will vaporize at the same temperature as an Eastern one of 70° to 72°. Californian gasolines when properly graded or blended will give good results.

Another important requirement for satisfactory gasoline is that it should be free from substances which would deposit on the working-surfaces of the cylinders and valves to form a hard coating. The best gasoline will cause deposits if the air is not correctly proportioned to give perfect combustion, but occasionally gasolines are found that contain a small proportion of the base from which they are distilled, probably carried over during distillation. This will not burn, but remains on the surfaces in the form of a hard black deposit that is difficult to remove.

Air at a given temperature will absorb a fixed amount of gasoline-vapor, depending on the gravity, and will become saturated. In Technical Paper No. 127, U. S. Bureau of Mines, the following proportions of gasoline-vapor required to saturate air at a temperature of 63.5° F. are given:

| Grade of gasoline | Vapor, % |
|---|---|
| Cleaners naphtha | 5 |
| 64°B. | 11 |
| 69°B. | 15 |
| 73°B. | 28 |

One gallon of gasoline when entirely vaporized will produce 32 cu. ft. of vapor, or about 240 times its original volume, and will render explosive 2100 cu. ft. of air. The percentage of gasoline vapor in air that will render it explosive as a mixture, is confined between rather narrow limits, 1.4 to 6.0%. This shows the necessity for a careful adjustment of the carbureter to obtain the most economical results in a motor.

Gasoline is sold by the gallon. The low-gravity gasolines weigh more per gallon than do the high-gravity fuels. The amount of energy that can be obtained from a heavy gasoline is greater per gallon than from the lighter grades, provided the proper adjustments are made in both cases. It has been stated that a small amount of paraffine-base lubricating-oil, mixed with the gasoline, will tend to keep the engine and valve surfaces clean in motors of the 'L-head' type, but not those having the valves in the head. The amount required is quite small, about one ounce in ten gallons.

There are on the market certain mixtures which are claimed, when mixed with the gasoline, to put 'pep' into a motor. They consist of a small proportion of highly volatile liquid, which vaporizes at a low temperature and serves to ignite the heavier portions of the gasoline, resulting in a more perfect combustion. The results of the use of one of these mixtures have been satisfactory, but the evidence is too limited to justify a positive statement as to their general utility.

The following results were obtained from the fractional distillation of samples of gasoline purchased from the regular service-stations in San Francisco in gallon quantities and preserved in carefully stoppered bottles until tested. The tests were made with 250 cc. in each case in order to obtain a sufficient quantity of each fraction to measure the gravity by means of a hydrometer.

| Temp. F. | Company A | Company B | Company C | Company D | Distillate Company B |
|---|---|---|---|---|---|
| 160° | ... | 10.4 | 13.2 | 11.2 | ... |
| 170° | 12.4 | 15.0 | 15.2 | 22.6 | ... |
| 190° | 19.8 | 22.8 | 23.2 | 25.6 | ... |
| 210° | 27.4 | 34.8 | 34.0 | 32.8 | ... |
| 230° | 40.2 | 54.2 | 53.4 | 42.2 | ... |
| 250° | 52.4 | 69.6 | 72.6 | 57.8 | 12.4 |
| 270° | 72.6 | 81.2 | 86.8 | 68.0 | 36.4 |
| 290° | 84.2 | 90.4 | 94.6 | 81.6 | 57.8 |
| 310° | 91.2 | 95.2 | 97.8 | 88.4 | 76.7 |
| 330° | 96.6 | 98.2 | ... | 93.8 | 84.1 |
| 350° | ... | ... | ... | 98.0 | 89.7 |
| 360° | ... | ... | ... | ... | 91.9 |
| 370° | ... | ... | ... | ... | 93.6 |
| 380° | ... | ... | ... | ... | 97.4 |
| Gravity of sample. | 55.0 | 55.0 | 55.8 | 57.0 | 48.0 |
| Residuum | black | none | none | light | light |

The residuum in the Company A gasoline, after evaporation to dryness, consisted of brilliant black particles adhering firmly to the dish. The quantity obtained amounted to 0.1 milligramme per cubic centimetre or 0.3785 grammes per gallon.

That from the Company D gasoline was light brown and amounted to 0.031 gramme per gallon.

From the Company B distillate the residuum was light brown and amounted to 0.0465 gramme per gallon.

This summary of information is tendered with the hope that it will prove useful to those interested in the economical operation of their cars. It can hardly be called more than a slight introduction to the subject. For those desiring to investigate further, the following list of publications is given.

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## EXPANSION AND CONTRACTION OF CONCRETE AND CONCRETE ROADS

Bulletin No. 532 of the U. S. Department of Agriculture, by A. T. Goldbeck and F. H. Jackson, Jr., on 'The Expansion and Contraction of Concrete and Concrete Roads,' is based on measurements of cement and concrete specimens in the laboratory under various conditions of seasoning, and on measurements of the concrete pavement on parts of the Chevy Chase road in Maryland, and the Ohio Post Road in Ohio. The following conclusions are given:

1. Neat cement when allowed to dry, first contracts rapidly, then more slowly. The amount of contraction seems to vary with the cement, size of specimen, and condition of the atmosphere when drying takes place. The amount at 28 days is about 0.1% and at 6 months 0.2%.

2. Mortar contracts on hardening in air and expands on hardening in water. The contraction in warm dry air at 28 days is about 0.045% for 1:2 and 1:3 mortar and at 6 months is 0.078% for 1:3 mortar and 0.085% for 1:2 mortar. The expansion in water is 0.01% for 1:3 and 0.017% for 1:2 mortar at 28 days, and 0.013% for 1:3 and 0.02% for 1:2 mortar at 6 months.

3. Both 1:2:4 and 1:3:6 concrete contract on drying in warm dry air from 0.02 to 0.04% at 28 days and from 0.04 to 0.07% at 6 months. When hardening in water an expansion of about 0.01% takes place at 28 days in 1:2:4 and 1:3:6 concrete. This does not change appreciably at 6 months.

4. The richness of the mix of concrete seems to exert a small influence on the contraction; the richer the mix the greater the change in length.

5. Concrete alternately wetted and dried may be made to expand and contract accordingly. The expansion because of wetting is more rapid than the contraction on drying. Thoroughly dried specimens of concrete do not recover their original wet-length when immersed.

6. Concrete stored in the outer air and exposed to the weather does not contract to the same extent as the above described specimens except under dry conditions.

7. A waterproof covering, such as coal-tar, prevents the rapid change in moisture-content and retards expansion and contraction greatly.

8. Reinforcement decreases, but does not prevent, the shrinkage and expansion of concrete resulting from drying and has no effect on temperature changes. Reinforcement can not, therefore, prevent cracks entirely, but seems to distribute them and keep them small.

9. Concrete roads are affected by both temperature and moisture. When the drainage is good and the sub-base not wet, the temperature effects seem to be most important. A wet sub-base may add to the temperature expansion by about 0.01 to 0.02%. The restraining effect of friction at the base seems to be almost negligible when figuring expansion and contraction resulting from temperature and moisture. In dry climates shrinkage because of drying must be added to contraction from decrease in temperature. A safe allowance for shrinkage from drying is 0.04% or $\frac{1}{4}$ inch in 50 feet.

10. The temperature at the time of construction of the road should be considered in designing joints. Cold-weather construction requires a full allowance for temperature-expansion and, on wet sub-bases, for moisture-expansion also. Hot-weather construction theoretically requires no joints at all, even for wet sub-bases, as the temperature-contraction exceeds the moisture-expansion. However, the difficulty of keeping the cracks clear probably renders joints imperative.

## PREVENTION OF WEAR ON HOISTING-CHAINS

Wear on the outside of links of hoisting-chains takes place when the second wrap of chain starts winding on the drum. The chain climbs on the under wrap and in slipping down to a bearing, causes a tearing action, which wears the chain on the outside of the links, while the ends show but little wear. If the following simple method is adopted it will relieve this condition.

With a 'missing link' attach a piece of old chain long enough to make one and one-half wraps around the drum. After the chain has been in use a sufficient time to show considerable wear on the outside of the links where the second wrap begins, remove the old piece of chain and attach the end of hoisting-chain to the drum. This will place the wearing-faces on new sections, which are full size, and double the life of the links at this point.—'Excavating Engineer.'

**Zinc chloride** as a preservative has been shown by a student at the Massachusetts Institute of Technology to be unsafe for timber intended for certain building purposes. When the treated wood is kept at 150° F. for forty days its breaking strain is reduced to 38% of the normal. In certain factories where high temperatures are the rule untreated timber would be stronger.—'Mechanical World.'

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# Operation and Management of an Irrigation Project

The following discussion, which is condensed from a report by Fred D. Pyle, project manager, to A. C. McClanahan, president of the Uncompahgre Water Users' Association, and printed in the 'Irrigation Age', applies to other irrigation projects as well.

One of the things which must be carefully considered in the future operation of the project is a proper balance between efficiency and economy. Good service must be the first consideration and every possible effort should be made to maintain good service in the most economical manner. The saving of a few thousand dollars in cost of operation may easily result in the loss of crops valued at a much larger amount.

The executive organization will consist of a board of directors, from which will be selected a president, vice-president, and possibly a secretary and treasurer. This board should attend to all matters of policy, such as rules and regulations concerning collections, methods of water delivery, financing of the work, organization of operating forces, grievances, winter-water, hours of work, and salaries.

The board should select a manager or superintendent, who should have charge of the operation and maintenance of the project, and who should also have charge of equipment and buildings and be responsible for expenditures. All unusual expenditures, however, should be approved in advance by the board of directors. The superintendent's organization should consist of an assistant manager, who will spend practically all of his time in the field, two water-masters, a hydrographer and ditch-rider, headgate tenders, laborers, and teams as required. The superintendent should be given complete charge of his organization and be held responsible for the results accomplished.

A man will be required to handle routine office-work and purchases; another for the collections and disbursements; another to do the bookkeeping. Stenographers will also be required, and at times special men to handle collections. The above-mentioned men may report to the superintendent or to the president. It is possible for the secretary to act as office-man and for the treasurer to act as field agent. However, there are some drawbacks to this arrangement on account of the difficulties encountered in removing them from office if they are not competent, provided they occupy positions as directors of the organization. In addition to the above, legal advice will be required from time to time. If the superintendent is not an engineer, engineering advice will be needed as the occasion arises. The collection and disbursement vouchers should be audited annually by a regular firm of accountants.

The organization can be financed on a cash basis by collecting part of the charges December 1, and the remainder before water is delivered, or on a part credit part cash basis, borrowing money from the banks until the collections are made prior to delivery of water, or on a credit basis, borrowing money to be repaid when collections are made at the end of the season. The part credit part cash proposition is probably the most feasible because the association, when properly conducted, will have better credit facilities and will be able to borrow money at a lower rate of interest than can the individual farmer.

A system of accounting will have to be established. Certain men who are entrusted with funds will have to be bonded. Cost reports will have to be made, also annual reports to the stockholders.

The following are a few of the many points that will have to be considered in making rules and regulations regarding the delivery of water: winter-water; waste water; regulation of turn-outs by water-users; fences, flumes, bridges, etc., across canals; continuous flow versus rotation; collection of operation and maintenance charges on the basis of acre-feet furnished rather than acres irrigated.

It must be kept in mind that the measurement of water to farmers is just as necessary as the weighing of groceries to a customer of a grocery store; that the only practical way to measure water is by weirs and spill-boxes, or by gauging-stations and current-meters. The last method is the only practical one for canal and river stations. It is necessary for the management to know just how much water is available at any time and how much is being used or is required by the various canals. This information is of particular value in making the proper distribution of water during periods when all available water is being used.

You will find that the demand of the actual water-user will be for better service, which will require careful measurement and accurate records of the amount delivered at all turn-outs.

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**A narrow-gauge flat-car** with a wide body has been built for the South African Railways by the Leeds Forge Co., of Leeds, England. It is described in London 'Engineering.' The car is of steel, weighs 74,700 lb., and has a capacity of 160,000 lb. Although designed to run on a 3 ft. 6 in. gauge track, the width of the car-body is 12 ft. 6¼ in. It is used for hauling whales from a port near Durban, South Africa, to a factory a few miles away, where they are cut up for rendering. It is evident that such a wide car could not run in general traffic on account of clearance-limits, even on American standard-gauge lines. Its use on a narrow-gauge road shows the possibility of increasing the width of rolling stock wherever clearance-restrictions do not apply.

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# Electrolysis in Underground Water Pipes*

By J. W. IVY†

Soon after electric railroads were introduced in this country underground pipe systems began to show damage from electrolysis. Before that time little or no trouble had been experienced. With the multiplication of electric lines the situation has become more serious. The problem is receiving attention at the hands of the U. S. Bureau of Standards, various engineering societies, and other interested organizations. It will be the purpose of this paper to deal only with electrolysis as affecting underground pipes in water systems. However, before going into a discussion of this matter, it is desirable to state briefly the general principles involved and to define a few technical terms that will be used.

Certain solutions or chemical compounds are capable of conducting an electric current. Such solutions or compounds are called electrolytes, and the transmission of an electric current under these conditions is called electrolytic conduction. This differs from ordinary metallic conduction, such as the passage of a current through a copper wire, in that electrolytic conduction is independent of any heating effect and produces chemical decomposition, whereas metallic conduction produces heat in the metal, but does not otherwise affect it. This chemical change of decomposition produced by the passage of the electric current is called electrolysis. A common example of this action and one of the forms in which it is usefully employed is the process known as electro-plating. The operation consists merely in passing an electric current through a solution of copper salt (or salt of whatever metal is desired), the conducting terminals, or electrodes, being of copper plate; copper is removed from one terminal and carried into solution, and an equal quantity of copper is deposited on the other terminal. The terminal through which the current enters the solution is called the anode, and the terminal at which the current leaves the solution is called the cathode.

**Electrolysis from Stray Currents, Anodic Corrosion.** In this age of electricity there is abundant opportunity for electric current to leak into the soil from numerous grounded distribution-systems. For our purposes we need consider only stray currents that have leaked from the return conductors of ordinary street-railway systems, the currents resulting from grounded telephone, telegraph, and lighting-system apparatus not being of sufficient strength to cause any serious trouble in pipe-lines.

Most electric railways in this country employ direct current, the power being supplied to the cars through an overhead trolley-wire and the return circuit to the power-house being completed through the rails. It is common practice to lay these rails with the tops flush with the street-surface. Under such conditions most of the rail-area is in direct contact with the street-soil, or with the concrete where concrete has been used as a base. The water found in such soils or concrete usually contains salts, acids, etc., sufficient to make it capable of electrolytic conduction. Hence, either the wet concrete or the wet soil is capable under ordinary conditions of conducting electric currents. Current from the return-rails that flows or leaks into the soil or concrete must find its way back to the power-house through some underground path. In doing so the current obeys the law of divided circuits, flowing through all possible paths in parallel, the strength in each path being inversely proportional to its resistance. Underground water-piping systems readily offer themselves as convenient conductors of these stray currents, especially where the rails cross, or parallel the pipe in close proximity. In general, these currents flow along the pipe until they reach the neighborhood of the power-house, and at the nearest point to this leave the pipe, return through the soil to the rails, and thus back to the negative terminal of the generator. Where the current leaves the pipe and flows back to the rails the pipe serves as the anode, the soil as the electrolyte, and the rails as the cathode. These currents do no harm to the pipe except where they leave it. At such points the pipe is corroded. The extent of corrosion, or amount of metal destroyed is in keeping with Faraday's law, which holds that chemical decomposition occurring at the electrodes is directly proportional to the current flowing, the duration of flow, and the chemical equivalent weights of the substances. The destruction of the metal is independent of voltage, except the determining effect of this on current flowing.

In addition to the damage occurring in the vicinity of the power-house, which is by far the greatest and most serious source of trouble, the pipe is also affected at other points where currents leave the pipe, either to shunt around some high-resistance section or to return to the rails because of favorable soil-conditions or close proximity of the tracks. This is particularly true in the case of cast-iron, where some lengths of pipe may have unusually high resistance, or else the lead joints are made so that the pipes themselves are not in direct contact. However, this is really an advantage rather than otherwise, because it has a tendency to reduce the total current, causing part to leave the pipe and

*Abstract of paper read at the South-Western Waterworks Association Convention at Topeka, Kansas.

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seek some other path, such as the rails, back to the power-house. Under these conditions the total current leaving the pipes at the power-house is small, much smaller than the accumulated current would have been had there been no loss or leakage. Wherever the pipe-lines parallel the rails and pass through unusually wet soil there is more danger of serious trouble, such conditions lending themselves readily to the passage of current to or from the pipe or rails.

Under similar conditions with currents of equal strength, the amount of metal destroyed is the same, whether the pipe is steel, wrought-iron, or cast-iron. However, because of its inherent qualities and peculiar metallic structure, the resistance offered to the flow of electricity by cast-iron is, roughly, ten times as great as steel or wrought-iron. The ordinary lead joints employed with cast-iron increase this resistance materially, thus reducing the current flowing proportionately. This makes the possibility of electrolysis in the case of cast-iron approximately one-twelfth what it would be for the other two kinds of pipe mentioned. It should also be remembered that in practice cast-iron pipe has a thickness about four times that of wrought-iron or steel, which delays proportionately the ultimate destruction in the case of this class of pipe.

If the pipe be of steel or wrought-iron, results of electrolysis are seen in pits, these finally extending through the plate. Where the current leaves such pipe the metal is converted into iron oxide, which is frequently noticeable in surrounding soil. If the pipe be of cast-iron, the oxides formed often are still held in position by the graphite, and the external appearance of the pipe remains unaffected. When the pipe has been completely corroded the mass is about the hardness of pencil lead and collapses under an ordinary hammer stroke. However, a pipe in this condition, if the soil is packed tightly about it, may remain without leaking for a considerable period. It is frequently necessary to make a direct physical examination of a pipe and subject it to a hammer test to determine if it has been attacked by electrolysis.

So far, we have dealt only with trouble in the mains and distribution system proper. However, while less serious, probably the greatest amount of damage occurs in the service-pipes, because these frequently pass under the car-lines close to the rails, and the pipes, being relatively thin, are quickly pierced. Investigation made in about fifty cities brought out the fact that, roughly, 75% of the trouble experienced occurred in the service-pipes, lead, wrought-iron, or steel, all being readily affected. Besides the damage to the service-pipes themselves, stray electric currents flowing on these may occasionally reach the steel structure of buildings, causing electrolysis to attack the steel, but seldom to any serious extent. Under certain unusual conditions, current flowing on these service-pipes may be sufficient to raise them to a temperature approximating red-heat, and in this way causes fires. In some cases of gas-pipes, explosions have resulted. However, such occurrences are rare, and there seems no good reason to anticipate any increase in this hazard.

**Electrolysis from Local Action, Self Corrosion.** In addition to anodic corrosion we have what is termed self-corrosion, that is, electrolysis by local galvanic action. The current originates on the metal itself, and is caused by impurities of the metal or by the presence of carbon or coke in the surrounding earth, or by both. Salts and acids in moist soil increase this action. Small pieces of coke or carbon in wet soil in contact with the pipe, even if no physical differences between adjacent parts of the metal exists, will bring about local action, because a difference of potential will exist between the carbon and the iron which will cause current to flow from the pipe to the carbon. The potential difference existing under such conditions is approximately 0.5 volt—causing a sufficient flow of current to bring about rapid deterioration.

An instance of this kind came to my attention where a large coated steel pipe passing through a cinder-bed failed completely in a short time, the metal structure of the pipe becoming a mere honeycomb of rust. Self-corrosion is undoubtedly accelerated where anodic corrosion exists, galvanic action following as a secondary reaction. The primary action resulting from the stray currents produces iron oxide which is precipitated on the pipe-exterior. This oxide acts in the same way as a piece of coke in the case previously cited, bringing about a current-flow due to the potential difference existing. The general effect of self-corrosion on iron pipes differs little, if any, from the effects of corrosion by stray currents. It is often difficult to distinguish betwen the two actions. This has led to disputes in an attempt to place the responsibility for electrolysis troubles, it being the practice in many cities to force the railway companies to pay for all the damage caused by electrolysis.

However, it should be stated that, in the case of cast-iron at least, except where this is laid in damp cinder beds or like materials, the local action is seldom, if ever, sufficiently severe to cause the destruction of the pipe within the period of years usually ascribed to the life or usefulness of the ordinary pipe-line. In other words, since most of the mains and distribution systems in our cities are of cast-iron, there is not much trouble to be expected, except under unusual local conditions, from electrolysis other than that caused by stray currents that have leaked from electric-railway systems. Because of the growth of interurban lines many small towns that have no street-railway systems of their own are no longer free of possible trouble from electrolysis.

**Mitigation of Electrolysis.** More careful attention to proper bonding of rails would materially lessen the trouble by reducing the leakage of current from the rails. This has been done in European countries, particularly England and Germany. Many patented devices or so-called mitigation systems have been brought out. In some instances these have seemed to work satisfactorily. In other cases results have not been so

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good. Local conditions differ so widely that a system that might answer in one city would do little good in another. I consider these systems still in the experimental stage. In this country many cities have attempted to lessen the evil by bonding the pipe to the rails at frequent intervals, employing some good conductor like copper wire in this operation. In most cases this method has been attended with only indifferent success. In my opinion it is more likely to prove a detriment than a help, because it is likely to increase rather than decrease the current leaving the pipe at points not in the neighborhood of the power-house, as the bonding would have a tendency to cause a larger current-flow than would otherwise be the case.

Many paints, dips, tar and fabric coatings, and insulating-coverings have been placed on the market. After extensive experiments and practical tests, it is yet to be proved that such coverings, except possibly asphaltum one or two inches thick, are of much, if any, value. Many of these coverings, such as pitch and burlap wrappings, increase rather than decrease the action of electrolysis.

Fairly satisfactory results have been obtained by introducing insulating-joints in pipe-lines at proper intervals. Further developments along this line promise good results, provided experiments prove that the insulating-joints can be inserted economically. Some cities have tried drainage to reduce the likelihood of electrolytic conduction. So far these experiments have not been productive of good results, and the opinion seems to be growing that the cost is excessive in comparison with results obtained. So far, the only method of securing absolute immunity from electrolysis is to insulate the return-circuit perfectly. Several cities, notably Havana and Cincinnati, have accomplished this by providing an overhead return-wire. Others have their return circuit through insulated underground conduits. At present a committee composed of representatives from engineering societies and kindred associations, organized into what is known as the American Committee on Electrolysis, are giving the subject of electrolysis-mitigation close study.

The following conclusions may be stated:

1. Electrolysis-trouble increases as electric tramways become more numerous and the loading becomes heavier.

2. Stray currents are the principal and most troublesome source of damage. This damage is confined to points where currents leave pipes.

3. Anodic corrosion in underground pipe-lines is traceable to currents that have leaked from imperfectly insulated return-circuits of electric railways.

4. The really serious damage is confined to the neighborhood of the power-house, except under certain peculiar local conditions, such as unusually wet soil or cinder beds.

5. Service-pipes furnish the greatest number of failures in a short period of time, lead, steel, or wrought-iron being all readily attacked.

6. The higher electrical resistivity of cast-iron and the extra thickness of metal presented reduces the possibility of ultimate destruction of this class of material as compared with ordinary steel or wrought-iron pipe.

7. Self-corrosion, except under unusual conditions, is not sufficiently serious to cause complete failure of cast-iron, though it might destroy iron of thinner structure.

8. Paints, dips, fabric-coatings, etc., are of little or no value in migitating electrolysis, fabric-coatings especially tending to increase rather than decrease the damage.

9. Better bonding of rails, introduction of insulating-joints, and similar measures have so far proved the most helpful methods of electrolysis mitigation.

10. Absolute immunity from stray-current damage can be obtained only by insulated return-circuits.

## TEN SAFETY COMMANDMENTS

The following commandments are suggested by the National Safety Council:

1. Thou shalt have no thoughts other than those of thy work.

2. Thou shalt take no unnecessary risks nor try to show off nor play practical jokes, for by thy carelessness thou mayest do injury which will have effect unto the third or fourth generation.

3. Thou shalt not swear nor lose thy temper when things do not come just right.

4. Thou shalt not clean machinery while it is in motion.

5. Remember that thou art not the only one on the job, and that other lives are just as important as thine own.

6. Honor thy job as thyself, that thy days may be long in employment.

7. Thou shalt not watch they neighbor's work, but attend to thine own.

8. Thou shalt not let the sleeves of thy shirt hang loose nor the flaps of thy coat unbuttoned, as they may get caught in the machinery.

9. Thou shalt not throw matches or greasy waste on the floor, nor scatter oil around bearings, as a dirty worker is a clumsy worker, and a clumsy worker is a menace to his fellow-workers.

10. Thou shalt not interfere with the switches, nor the cables, nor the engines, nor anything else that thou art told is dangerous.

**Gauge-glasses** showing water-levels at the Cobb's Hill reservoir, Rochester, New York, are made more legible by providing two black stripes ¼ in. wide and ¼ in. apart on the back of the tubes. The refraction of the light passing through the water-column causes the bands to appear wider than they actually are, and thus indicates the exact water-level. The relative positions of the levels can be seen easily across the 20-ft. room of the gate-house.—'Mechanical World.'

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# The Strength of Nailed Joints*

By H. F. BLOOD† and H. E. PLUMMER‡

The tests discussed in this report were made on behalf of the Bureau of Buildings of the City of Portland, in order to obtain information regarding the strength of nailed joints and other connections with douglas fir and western hemlock, primarily as a basis for checking plans submitted to the Bureau.

While a number of tests have been made to determine the resistance of nails driven into timber both to pulling out and to lateral movement, eastern varieties of timber have been generally used and no satisfactory records could be found by the Bureau of Buildings of tests made to indicate the lateral resistance or strength in single shear of nails driven into douglas fir or western hemlock. Of course, it might be contended that an engineer could make use of tests of joints in eastern timber by comparing the physical properties of the wood used with those of douglas fir or western hemlock, but such a procedure is open to objection as being inaccurate because of the many varying factors to be taken into consideration.

This report covers the testing of 110 joints, of which 87 were made of douglas fir and 23 of western hemlock. There were 94 joints of douglas fir tested but 7 are not included in the report because the testing-machine, which was run at a high rate of speed, gave results that were unsatisfactory. It was not possible to take readings accurately as the slip was rapid.

The tests were divided into two series, depending upon the style of the joints. In Series I, two side-pieces, each with the grain of the wood vertical, were nailed to a centre-piece with the grain of the wood horizontal. Fig. 2 shows the arrangement of the pieces and joints.

In Series II, two side-pieces, each with the grain of the wood vertical, were nailed to a centre-piece with the grain of the wood also vertical. Fig. 2 shows the arrangement of the pieces and joints.

In Series I, joints both of douglas fir and western hemlock were tested, but in Series II, joints of douglas fir only were tested. In making the tests, it was desired to introduce such variables that the lateral resistance of nails under various conditions be clearly brought out and understood. With this in mind, the number of nails in a joint and the size of the nails, as well as the size of the side and centre-pieces were varied. The size of the side-pieces ranged from 1 by 6 in. to 3 by 8 in., and the centre-pieces from 4 by 6 in. to 6 by 10 in., the dimensions given indicating commercial size, which is from $\frac{3}{8}$ to $\frac{1}{4}$ in. less than the dimensions given. The nails used were common wire-nails, ranging from 10D to 60D in size. The number of nails used in each side-piece ranged from two to five. The size of the pieces was such that the nails had a penetration in the centre-piece of from 30% to 80% of the length of the nail, but the nails were always used in single shear, in no case passing through the centre-piece. All timbers were surfaced so that contact in the joints was between planed surfaces only.

The joints were tested by placing them in a Riehle testing machine and forcing the side-pieces down and past the centre-piece. Accurate measurements were taken of the relative movements of the pieces comprising the joints. Fig. 1 shows the joints in place in the machine ready to test and with scales in position ready to indicate movements. In addition to the two series of tests mentioned above, two joints were tested in which the nails were driven parallel to the grain of the wood.

The following is a summary of the results obtained by the tests. The average ultimate load carried per nail is as follows:

SERIES I—DOUGLAS FIR

| No. of tests | Size of nail | Ultimate load carried per nail |
|---|---|---|
| 14 | 10D | 525 |
| 9 | 16 " | 600 |
| 10 | 20 " | 749 |
| 10 | 30 " | 922 |
| 5 | 40 " | 1183 |
| 1 | 60 " | 1800 |

SERIES II—DOUGLAS FIR

| | | |
|---|---|---|
| 5 | 10D | 407 |
| 9 | 16 " | 628 |
| 12 | 20 " | 751 |
| 6 | 30 " | 992 |
| 4 | 40 " | 1023 |
| 1 | 50 " | 873 |

SERIES II—WESTERN HEMLOCK

| | | |
|---|---|---|
| 6 | 10D | 519 |
| 4 | 16 " | 588 |
| 7 | 20 " | 695 |
| 6 | 30 " | 979 |

An inspection of the above values shows the irregularity and apparent unreliability of the single test made on the 50D and the 60D joint. The resistance of the 50D joint for some reason was low, while the resistance of the 60D joint was high. A curve of the resistances as indicated by the tests shows uniformity for the 10D, 16D, 20D, 30D, and 40D nails but shows pronounced breaks for the 50D and 60D nails. (See Plate I). The average ultimate load per nail carried by

*Abstract of report prepared for the Bureau of Buildings, Portland, Oregon.

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header-joints with nails driven parallel to the grain in the wood was 446 lb. for 16D nails.

The following conclusions may be stated:

1. The tests indicate that safe working-loads for nails driven perpendicular to the grain in douglas fir or western hemlock and with a load perpendicular to the length of the nail are as follows:

| | Lb. | | Lb. |
|---|---|---|---|
| 10D nail | 120 | 30D nail | 270 |
| 12 " " | 120 | 40 " " | 320 |
| 16 " " | 160 | 50 " " | 400 |
| 20 " " | 200 | 60 " " | 480 |

These values should be reduced if the penetration of

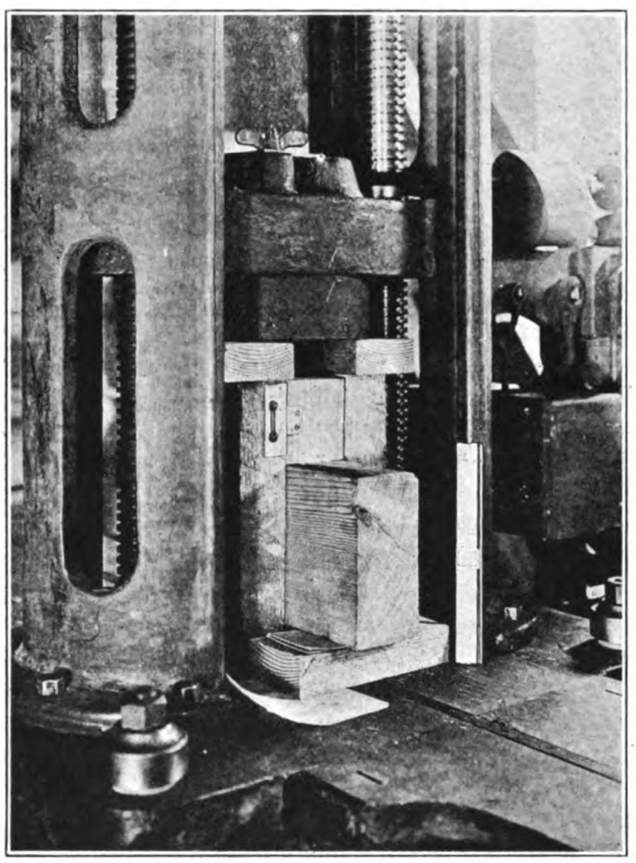

FIG. 1. JOINTS IN POSITION FOR TESTING

the nail in the holding-piece is less than 50% of its length. They give a factor of safety based on the ultimate strength of considerably over three in all cases and in most cases of nearly four.

2. The resistance of nails driven perpendicularly into timber with the grain parallel to the loads is but little more than it is for nails similarly driven with the grain of the wood perpendicular to the load. This difference is so slight that the loads recommended are the same for both cases.

3. The tests of nails driven parallel with the grain of the wood with the load perpendicular to the length of the nail indicate that the safe loads given for nails driven perpendicular to the grain of the wood should be reduced 25%, as follows:

| | Lb. | | Lb. |
|---|---|---|---|
| 10D nail | 90 | 30D nail | 200 |
| 12 " " | 90 | 40 " " | 240 |
| 16 " " | 120 | 50 " " | 300 |
| 20 " " | 150 | 60 " " | 360 |

Tests were made on the 16D size only but the reduction in safe loading was considered to be the same for all sizes.

4. The tests show that nails in western hemlock have so nearly the same resistance as in douglas fir that the safe loads may be considered the same.

5. Slip occurred under small loads and increased in proportion to the load until the ultimate load was reached, after which it continued with a decreasing load until failure occurred.

6. In the tests, no elastic limit of joints could be determined. The recommendation of previous investigators that a slip of 0.1 in. be considered as the elastic limit seems reasonable since the load with such an amount of slip is from 50% to 60% of the ultimate strength.

7. The amount of slip is affected by the time-element and increases slowly over loaded periods of three to eight minutes. For joint No. 8 the slip occurred at the rate of 0.003 in. per minute for three minutes for a load one-half of the ultimate strength, and increased with increasing loads to 0.02 in. per minute just before the ultimate load was reached.

8. When the load is released after a small amount of slip has occurred, the joint does not come back to its former position but retains from $\frac{1}{16}$ to $\frac{1}{10}$ in. of permanent set. Upon re-loading to the amount of the first load, the slip did not increase beyond the original amount.

9. The tests indicate that the nail-heads are of proper proportions as there were no cases where the nail-heads pulled through the outside timber.

10. The strength of the joint seemed to be affected but little by the penetration of the nail in the centre-piece, provided the penetration of the nail in the centre-piece was 40% or more of its length. With lesser penetrations the strength was reduced. For a penetration of 30%, the reduction in strength was about 25%.

11. Each nail in a joint seems to take an equal proportion of the load.

12. Large nails do not offer as much lateral resistance as the smaller ones, either proportionately or per pennyweight.

13. The bearing of a nail on the wood when the joint approaches the ultimate strength is much more than values given for ultimate crushing strength of timber across the grain. In connection with the use of timber, it would seem to be well to consider that under certain conditions the loads imposed on timber across the grain may exceed the values commonly allowed.

14. The two principal factors involved in the strength of nailed joints are the resistance of the timber to crushing and of the nail to bending. The resistance of the nailed joint if depending solely on the resistance of

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the wood to crushing, varies as the diameter of the nail, other things being unchanged. On the other hand, the resistance of the joint if depending solely on the resistance of the nail to bending, varies as the cube of the diameter of the nail. As the resistance of the nailed joints depends on both the resistance of the wood to crushing and the resistance of the nail to bending, the resistance varies somewhere between the variation of the diameters and the cube of the diameters of the nails. This variation corresponds closely with the square of the diameter of the nails.

15. The tests show that further tests with a wider range of variables are desirable. These should include rough as well as finished timber and green as well as seasoned; nails covered with pitch; barb-nails and finishing-nails, etc. The tests might well include the effect of a falling load as well as one evenly applied, and also the effect of a load remaining in place for some time.

The douglas fir used in the tests was purchased from the Eastern & Western Lumber Co. and was cut in Cowlitz county, Washington. All pieces except the 6 by 6 in., 8 by 8 in., and 6 by 10 in. sizes were taken from stock that had been piled in the yard of the lumber company for about three months. These three sizes were sawed after the lumber was ordered, from logs which had been lying in the river near the mill. Most of the timber was from sound living trees. One 2 by 8 in. piece appeared to have been cut from a burned tree. The joints in which this piece was used developed a lower strength than the average. The number of rings per inch varied greatly in the different pieces and in different sections of the same piece. Usually, there was a good proportion of summer-wood. In some cases, one side or corner of a piece had from five to seven rings to the inch, while another side or corner had from fifteen to twenty-five rings to the inch.

The density varied considerably, the heaviest piece weighing 37.4 lb. per cu. ft. and the lightest piece weighing 31.5 lb. per cu. ft. The number of rings per inch did not seem to have much to do with the weight. In the lightest piece, there were six rings to the inch and in the heaviest piece a little over eight rings to the inch. The average weight per cubic foot was 33.8 pounds.

The timber was surfaced so that the faces in contact were planed in every case. The timber, after being received, was stored in the boiler-room and later removed to the engine-room. The temperature was higher than desired in these rooms and the wood checked somewhat.

The western hemlock was purchased from the Multnomah Lumber & Box Co. and came from the Grays River plant of the Columbia Logging Co., Nahkiakum county, Washington. The logs were cut in May and were rafted to Portland two weeks later and remained in the river until sawed. The hemlock was sawed shortly after the order was given. It was stored as described for the fir and checked during storage somewhat more than the fir.

The density varied considerably. The lightest piece weighed 27.6 lb. per cu. ft. after being stored 270 days. It had eleven rings to the inch. The heaviest piece weighed 31.2 lb. per cu. ft. after being stored 51 days. The number of rings to the inch was from ten to eleven. The average weight was 28.4 lb. per cu. ft. The wood was surfaced so that all faces in contact in the joints were planed.

Smooth wire nails purchased from the Honeyman Hardware Co. were used. They were manufactured either by the American Steel & Wire Co. or the Pittsburg Steel Works. The dimensions of the nails were as follows:

| | Length, in. | Diameter, in. | Diameter of head, in. |
|---|---|---|---|
| 10D | 3 | 0.147 | 0.30 |
| 12" | 3¼ | 0.147 | 0.30 |
| 16" | 3½ | 0.159 | 0.34 |
| 20" | 4 | 0.193 | 0.40 |
| 30" | 4½ | 0.208 | 0.45 |
| 40" | 5 | 0.226 | 0.48 |
| 50" | 5½ | 0.245 | 0.50 |
| 60" | 6 | 0.258 | 0.55 |

Three specimens each of the 30D, 40D, and 60D nails were tested for tensile strength. The ultimate strength ranged from 74,000 lb. to 93,600 lb. per sq. in., with an average of 87,435 lb. The elongation in 2 in., where it could be determined, ranged from 8.5% to 10.1%. The elastic limit could not be determined.

The joints were made by a skilled carpenter. Except where it was necessary to follow the grain of the wood somewhat in order to avoid splitting, the nails were driven perpendicular to the side-pieces. The tests were conducted under the direction of H. F. Blood of the Bureau of Buildings, assisted by Oscar Beck of the Bureau of Standards. The work was commenced in August 1915 and concluded in March 1916, mainly because the increase in the amount of other work performed by the investigators did not leave them sufficient time for testing.

In each joint, the nails were placed symmetrically and the same number of nails was used in each side-piece of a joint. In Series I the joints were placed in the testing-machine as shown in Fig. 1 and adjustments were made so that the bearing of the machine-head on the joint was even. The relative change in the position of the pieces was measured by a metal scale graduated to intervals of 0.1 in. and attached to a side-piece and a vernier-scale attached to the centre-piece which enabled the observer to read accurately movements of 0.01 in. and to estimate movements of 0.001 in. Two such scales were used on each joint at diagonally opposite ends. The machine-head was run downward at the slowest speed, or at the rate of 0.04 in. per minute. Readings of the amount of slip were taken in most cases at intervals of 50 or 100-lb. increments of load. In a few of the larger joints, the readings were taken at intervals of 200 or 300 lb. In testing a number of joints, the machine-head was run downward at a higher speed, but this rendered the taking of readings difficult and was discontinued. The bearing of the testing-machine on

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the joints was shown to be even as the readings of both scales of each joint were practically uniform for the various loads. In some instances there was a variation of from 0.01 in. to as much as 0.03 in. When there was any variation in the amount of slip in the two side-pieces of a joint, the average of the two was taken. There seemed to be but little difference between the

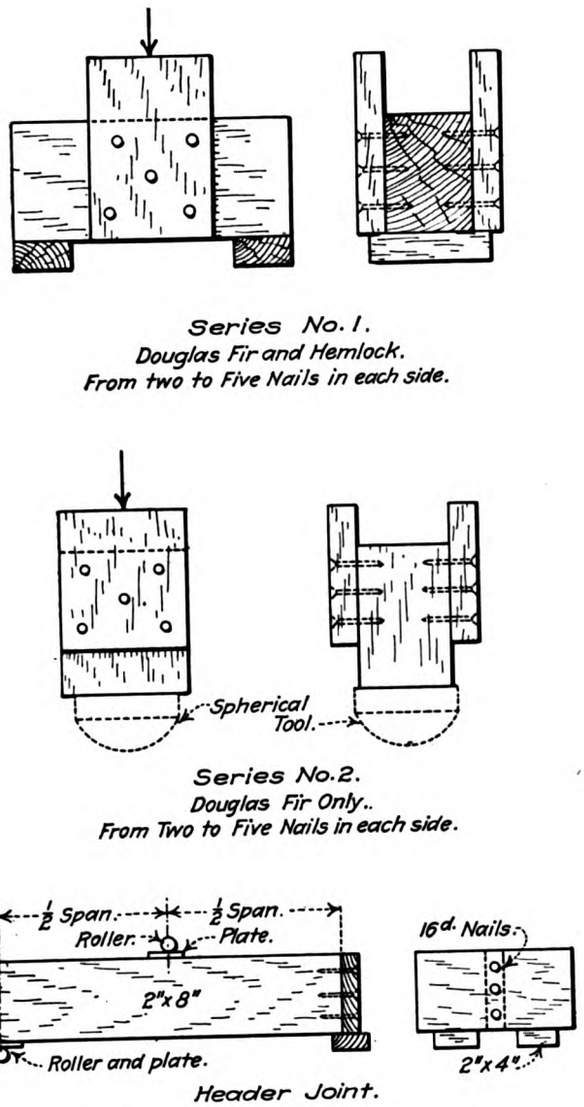


FIG. 2. METHOD OF CONSTRUCTING JOINTS

joints of douglas fir and western hemlock except that in making the joint, the hemlock seemed to split a little more readily, and also that the loads carried were not so large.

Many of the joints were tested until the side-pieces were entirely pushed off the centre-piece. It was found that slip occurred at small loads and increased at a somewhat uniform rate until the ultimate strength was reached. At this point the slip continued with decreased supporting-power of the joint. With the continuation of such reduced load, the side-pieces would move away from the face of the centre-piece until finally the nails would slip from the holes in the side-piece and absolute failure would occur. In some cases, after the ultimate strength was reached and the load began to decrease, the speed of the machine was increased to save time and the two side-pieces were pushed from the centre-piece. Fig. 3 shows the movement of side-pieces away from the centre-piece.

In Series II, the joints were inserted in the machine a little differently from the joints in Series I. A spherical bearing was used in the machine, upon which the joint was placed. Any difference in the two side-pieces was adjusted by the use of shims of tin or blotting-paper under the head of the machine. This simplified the work of placing the joint in the machine as compared to the method used in the Series I tests. In other respects the tests were conducted for Series II the same as for Series I.

In addition to the tests of Series I and Series II, two tests were made of a joint made of two pieces of douglas

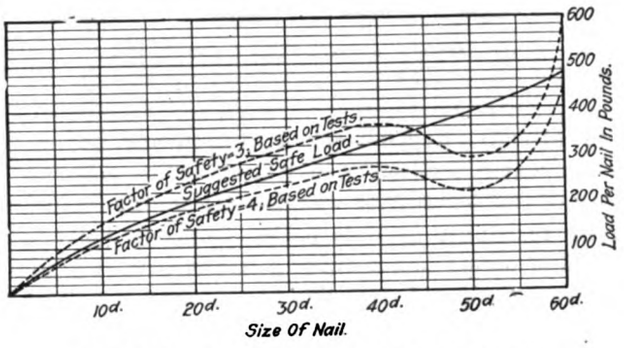


PLATE I. CURVES FOR SAFE LOADS ON NAILS

fir connected with nails driven perpendicular to the grain of one piece and with the grain of the second piece parallel to the length of the nail. The joint as shown in Fig. 1 is a joint in common use in frame-construction, where a joist is supported by a header and no joist-hangers are used.

The tests show slip begins in the joint at small loads and increases regularly with the increase in the loads. This is shown by Plates II and III. The curves not only show a regular rate of curvature for each joint but also show a similarity in the curve for different joints.

In order to ascertain the effect of a steady load held in position for a time joint No. 8 was tested in the regular way until the load reached 3000 lb., or a little less than one-half the ultimate strength. The load was held at 3000 lb. for three minutes and the changes in the slip during this time recorded. Then the load was increased by increments of 500 lb., and the load held at each increment from three to eight minutes. Table I shows the results of this test and indicates that for loads greater than one-half the ultimate strength the slip is continuous for short periods of time. The rate of slip increases as the ultimate strength is approached. The rate of slip at a load of 3500 lb. was about one-eighth of that which occurred under a load of 6800 pounds.

After testing, some of the joints were split open. One of these joints is shown in Fig. 3. The first effect of a load placed upon the joint is to bend the nail. This

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bending causes a compression of the fibres directly under the bent part of the nail. This bending takes the form of a reverse curve and as the load is increased, becomes permanent. As the bend in the nail increases, the distance from the head of the nail to the point shortens and the pointed end of the nail pulls out of the hole formed by the nail when it is driven into the timber. If this shortening of the nail took place along the length of the nail, the resistance of the nail would be

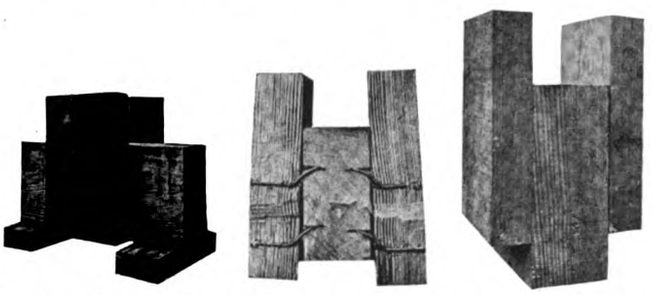

FIG. 3. JOINTS BEFORE TESTING, SERIES I AND II, AND JOINT SPLIT OPEN AFTER TESTING

slight after the first movement was effected, but as the nail is bent it tends to wedge itself in the hole. As a result of this bending or wedging action, the nail offers strong resistance as it is pulled from the hole. The failure of nailed joints under a steady load is gradual.

It was considered desirable to ascertain the effect on the slip of a joint of loading the joint, then releasing the load, and loading again. This was done on joint No. 10. The load on the joint was increased in the regular way to 4000 lb. when the slip amounted to 0.1 in. Then the load was increased to 500 lb., when the slip was reduced to 0.06 in. The load was then increased to 4500 lb., when the slip amounted to 0.14 in. Then the joint was tested in the regular way, failure occurring at 9210 lb. with a slip of 1 inch.

Nailed joints under small loads have a slip that is partly permanent when the loads are released. Joint No. 8 was tested in the regular way up to 3000 lb. with a slip of 0.45 in. The load was then reduced to 100 lb., when the slip fell to 0.15 in. The load was then reduced to 3000 lb., when the slip returned to 0.45 in., the same as for the first load of 3000 pounds.

TABLE I

Effect on Slip of Holding Loads
Joint No. 8 made with 10D and 20D nails

| Load in pounds | Slip in inches | Load held in minutes | Slip in inches during period | Slip in inches per minute |
|---|---|---|---|---|
| 500 ..... | 0.00 | .. | .... | .... |
| 1000 ..... | 0.00 | .. | .... | .... |
| 1500 ..... | 0.01 | .. | .... | .... |
| 2000 ..... | 0.014 | .. | .... | .... |
| 2500 ..... | 0.025 | .. | .... | .... |
| 3000 ..... | 0.044 | .. | .... | .... |
| 3500 ..... | 0.055 to 0.071 | 3 | 0.016 | 0.005 |
| 4000 ..... | 0.095 " 0.12 | 5 | 0.025 | 0.005 |
| 4500 ..... | 0.14 " 0.184 | 6 | 0.044 | 0.007 |
| 5000 ..... | 0.22 " 0.25 | 4 | 0.03 | 0.007 |
| 5500 ..... | 0.29 " 0.335 | 3½ | 0.045 | 0.013 |
| 6000 ..... | 0.405 " 0.485 | 8 | 0.08 | 0.01 |
| 6500 ..... | 0.515 " 0.63 | 6 | 0.115 | 0.019 |
| 6800 ..... | 0.655 " 0.775 | 3 | 0.12 | 0.04 |

At 6800 lb. failure took place.

The following bibliography has been prepared:

Bulletin No. 2, Engineering Experiment Station, Iowa State College. 'Holding Power of Nails in Single Shear.' By M. I. Evinger. Issued June 1908. Nails ranging from 8D to 60D, and white pine, yellow pine, spruce, fir, and oak timber were tested.

'Engineering News,' Vol. 31, January 11, 1894. 'Experiments to Determine the Holding Power of Nails and Drift Bolts. By F. W. Clay. In these experiments red oak was used.

'Transactions of the American Society of Mechanical Engineers,' Vol. 16, 1895. Tests by W. E. Barnes and R. O. Stillwell to determine force required for driving and pulling nails, recorded by R. C. Carpenter. The wood used was southern pine.

'Journal of the Association of Engineering Societies,' February 1896. Experiments made by Frank Soule on the resistance to pulling offered by nails in Douglas fir and redwood.

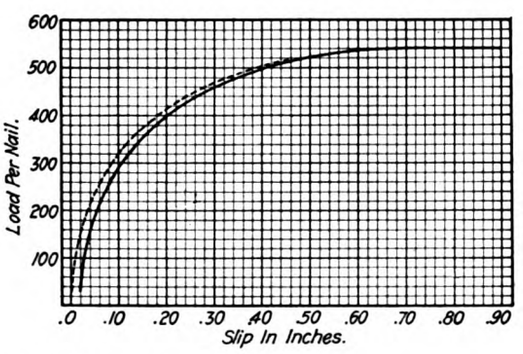


PLATE II. LOAD-CURVE FOR JOINT COMPOSED OF SIX 16D NAILS. READINGS FOR BOTH GAUGES, HEMLOCK TIMBER

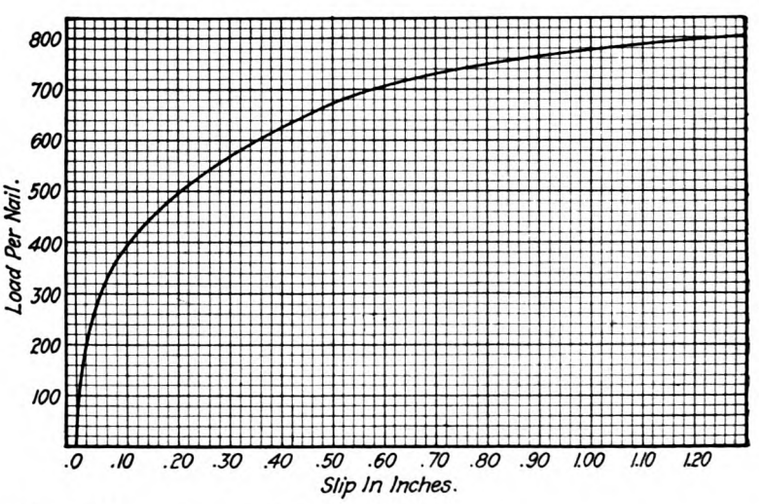


PLATE. III. COMPOSITE LOAD-CURVE FOR 20D NAILS, DOUGLAS FIR TIMBER

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'Tests of Metal,' 1884. Tests of the adhesive resistance of nails in timber. These tests were made at Watertown Arsenal upon white pine, yellow pine, white oak, and chestnut.

'Journal of the Association of Engineering Societies,'

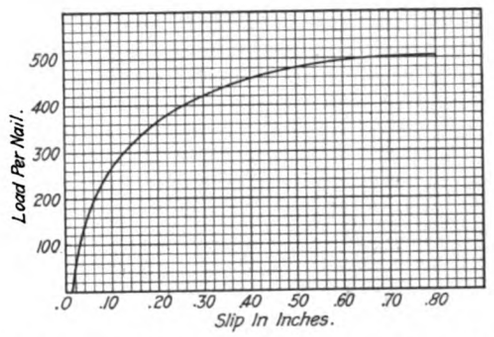


PLATE IV. LOAD-CURVE FOR JOINT COMPOSED OF TEN 10D NAILS IN HEMLOCK TIMBER

December 1897. Tests of the lateral resistance of nails in Norway pine, white pine, and oak. By F. B. Walker and C. H. Cross.

'Proceedings of the Indiana Engineering Society,' 1900. Experiments made by H. G. Darrow and D. E. Buchanan on the lateral resistance of nails. These tests were made at Purdue University and the results were published by W. X. Hatt.

'Structural Details.' By Henry S. Jacoby. Discus-

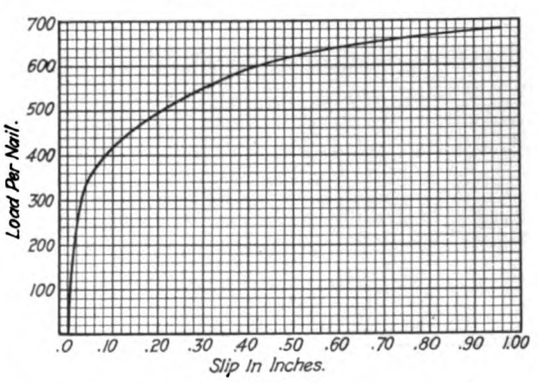


PLATE V. LOAD-CURVE FOR JOINT COMPOSED OF TEN 20D NAILS IN DOUGLAS FIR TIMBER

sion of the holding power and lateral resistance of nails. Various tests are mentioned.

In addition to the foregoing, it will no doubt be possible to find hand-books and other publications where data are given relative to strength of nails.

[To these references should be added 'Timber Framing,' by Henry D. Dewell, pp. 58-65.—EDITOR.]

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**The illuminating power** of kerosenes is discussed in a bulletin of the Iowa Engineering Experiment Station, Ames, Iowa. A greater relative flux of light for a given cost was obtained from the cheaper oils, the average cost of 1000 candle-power hours being $0.089 for a $0.10 oil, and $0.197 for a $0.27 oil. The average cost of all the samples tested was $0.19 per 1000 candle-power hours.

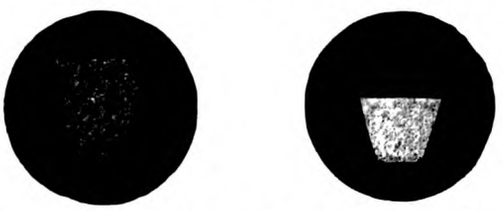
## HEAT-TREATED GEARING

By H. W. PHILLIPS

Steel gears may be divided as to material and structure into two general classes, alloy steels and carbon steels. Alloys of nickel, chrome, vanadium, and similar elements with the steel produce strong tough gears, which, however, because of their high cost, are practicable for only a few special uses. Most gears are necessarily of carbon steel.

Heat treatment increases the life of carbon-steel gears from 200 to 400%, while the increase of cost is only 25 to 50%. There are three general classes of treatment, namely, case-hardening, oil treatment, and other special treatment.

Where a gear must transmit a uniformly high torque without sudden jars or dynamic blows, case-hardening is suitable. Where the load to be transmitted is uni-



CROSS-SECTIONS OF ORDINARY AND SPECIAL HEAT-TREATED STEEL

formly low but with occasional shocks, the gear should have medium hardness but high ductility. This is supplied by oil treatment. In the majority of cases, however, the service imposes not only heavy duty with its resultant wear, but also shocks with the chance of breakage. It is for such service that specially treated gears have been developed. Several so-called special grades of steel have been introduced, one of them being the 'BP' grade manufactured by the R. D. Nuttall Co., of Pittsburgh.

By studying the chemical structure, a combination is obtained that, when subjected to a special treatment, possesses physical properties peculiarly adapted to gearing. The hardness at the surface is from three to four times that of untreated steel. This decreases slightly toward the centre of the tooth to two and one-half or three times as hard as untreated steel. This reduction in hardness is in a straight-line ratio. Every part of the steel from the surface to the centre, or neutral axis of the tooth, which may be slightly to one side of the geometric centre, will be stressed in proportion to its ability to carry the load. The ductility of this steel is comparatively high and is in inverse ratio to the strength. The surface of the tooth is both hard and tough and it will neither check nor spall. It is often advisable to treat the pinion only of a combination, it being the weaker and hardest-worked member. A pinion so treated is not likely to cause excessive wear on the untreated meshing gear. Some of the advantages from the use of treated gears are: lower ultimate cost of gearing, reduction of time-loss, reduction of labor-maintenance, and greater reliability.

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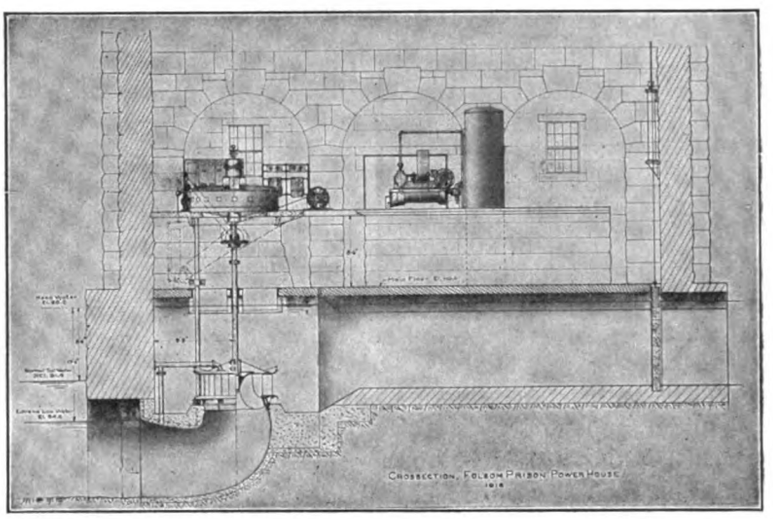
# Industrial Progress

## FOLSOM STATE PRISON INSTALLATION

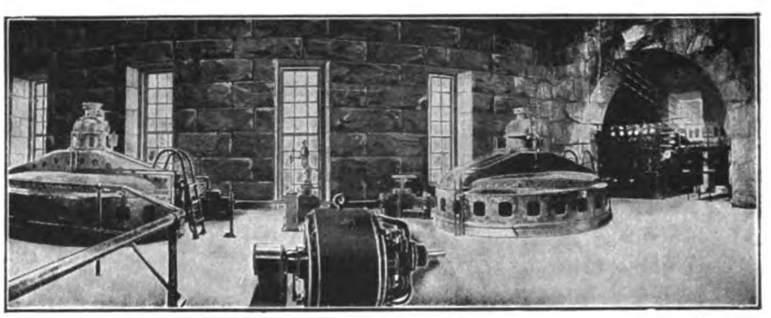
The State of California has recently established a new record for a low-head hydro-electric development, in connection with the installation made at one of the State Prisons, about two miles east of Folsom, on the south side of the American river, which is a tributary to the Sacramento, having its source in the Sierra Nevada range. This unusual harnessing of water-power is a triumph of present-day installation on the site of an original development, which, historically speaking, was the pioneer in power-tranmission, dating back to 1866. A project was inaugurated at that time to develop a manufacturing centre at Folsom, utilizing the water-power of the river in its fall between the town and the prison-site. The original development, it is understood, was made under about 7-ft. head, and consisted of six vertical-shaft turbines of 75 hp. each, the power being transmitted through bevel gears to a horizontal jack-shaft, from which, by means of rope-drives, a two-cylinder single-stage air-compressor and a horizontal plunger-pump, a refrigerating plant, and a machine-shop were driven.

The head and the flow present considerable variation and during several months of the year it is necessary to provide for power from outside. The variation in head is from 8½ ft. under normal conditions, to 12 ft. during exceedingly dry seasons, when the tail-water level is much lower. In other words, the variation in head on these turbines may amount almost to a 50% increase over the normal head, and it was necessary to select turbine-equipment for the new installation which would operate under these unusual conditions. It requires approximately 400 hp. to meet the demands of the prison, and the old granite flumes, extending underneath the power-house, in each of which was originally placed one of the 75-hp. turbines, were found to have a flow-capacity capable of handling about 300 cu. ft. of water per second within the limits of good engineering practice for maximum permissible velocity. It was, therefore, decided to place two turbines, one in each of two of these old flumes, and to make the turbines of sufficient capacity so that the two would develop the required 400 hp. This necessarily required a runner designed for high specific speed, having great water-capacity, in order to reduce the size of the generator as much as possible.

Each of the two vertical-shaft wicket-gate turbines recently installed has a runner of 51 in. mean diameter, operating at 100 r.p.m., and having a maximum capacity of 220 hp. under 8 ft. 6 in. head; 280 hp. under 10-ft. head; 365 hp. under a 12-ft. head, maintaining a constant speed throughout this variation of head. The design of the turbine is such that, while the power-output increases more than 50% when the head is increased to 12 ft., the efficiency of the turbine under the 12-ft. head is very high, which is an important factor in the plan of operation, because, when the head is low, there is ample water, and a slightly lower efficiency is not objectionable, but, with the higher heads which occur at low-water stage the quantity of water available is limited and the highest efficiency is therefore necessary in order to reduce the amount of power, which must be purchased from outside. The turbines are of the wicket-gate type, and consist of steel-bucket runners with hubs and bands of cast-iron, these runners being securely keyed to a vertical shaft and held in place by means of a split-ring recessed in the lower end of the shaft. There is no extension or shaft below the runner-hub, but the extension above the runner is of such length as to connect to the generator-shaft, a forged flange being provided for this purpose. This runner is mounted in the wheel-case, consisting of heavily constructed top and bottom plates, between which the wicket-gates are hinged on steel gate-pins extending through the gates and through the top and bottom plates in such manner as to be securely bolted and to be easily accessible for adjustment or replacement of any gates, which replacement can be made without interfering with the other parts of the turbine. The top plate is provided with a substantial steady bearing, in which lignum vitae blocks are placed, and which are adjustable to take up wear. The bottom plate is flanged so as to carry the shifting ring or gate-ring, which is connected to each gate by means of a link. The gate-links, as well as the gates, are bronze-bushed, and the connection to the gate-ring is made by means of an eccentric bolt which provides a slight adjustment to each individual gate. This gate-ring is operated by means of two push-and-pull rods which connect to a rocker-arm on the vertical gate-shaft, and to which connection is made on the generator-floor for governor and hand operation.




CROSS-SECTION OF TURBINE SETTING



GENERATOR-FLOOR, FOLSOM POWER-INSTALLATION

The accompanying cross-sectional illustration shows the vertical shaft, wicket-gate turbine complete with its vertical shaft, direct-connected generator, installed in the original masonry flume, in connection with which a curved concrete draft-tube has been carefully designed and constructed. This view also shows the extreme low tail-water level; also the normal tail-water level, and the normal head-water level.

In changing over this power plant, all the mechanical drives for the compressor and refrigerating plant were abandoned and all machinery was driven by induction-motors. The main

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power-house floor on which the generators are placed consists of an 8-in. slab of reinforced concrete at an elevation of 9 ft. above the main floor of the building, this being necessary in order to afford sufficient head room on this main or sub-floor, and also to provide for a jack-shaft between the two turbine-shafts. The object of the jack-shaft is to furnish power by means of belt-drives to the exciter, also the oil-pump which is a part of the governing mechanism, and also to drive the governor-speed balls. The counter-shaft is driven by means of rawhide bevel gears meshed in cast-iron bevel gears with split hubs clamped to the turbine-shaft. The two turbines are controlled by one governor of 10,000 ft.-lb. capacity, and it is so arranged that both turbines may be controlled by this one governor, or one turbine by the governor and the other by hand, or the reverse connection, or both may be regulated by hand, as the case may require. This makes an ingenious device which has been worked out carefully, and has operated successfully. The governor is placed on the generator-floor between the two generators with two operating cylinders of horizontal type set close to the floor so that the piston-rod of the operating cylinder extends through both heads. The connection is made to the gate-shaft of the turbine by means of a lever-arm carried on the ball thrust-bearing which supports the weight of the rotating gate-shaft. The hand-wheel mechanism is mounted in a substantial housing provided with an eccentric which is moved by a hand-lever. This arrangement works with extreme ease; in fact the turbine-gates are so designed that one man can easily handle them without difficulty, while the governor moves them with an oil-pressure as low as 60 lb. The generators are of special design because of the low speed and the unusually low capacity for machines of this speed. Each machine is a 72-pole alternator of 200 kva. nominal rating, wound to deliver 2300 v., 3-phase current. These machines were tested at a run-away speed of 200 r.p.m., or 100% over-speed, which is a condition that might occur with the turbines operating at a run-away speed under the maximum head of 12 ft. The rotor has a cast-iron spider, to the rim of which the 72 pole-pieces are bolted, this rim having considerably more weight than is necessary for the required strength in order to provide additional fly-wheel capacity for governing purposes, the fly-wheel effect in each rotor being 80,000 ft. sq. lb. The generator-shaft extends below the floor-level and is provided with a forged flange-connection to the forged flange of the turbine-shaft. The thrust-bearing on top of the generator carries a total load of 25,000 lb., which includes the weight of the revolving element of the generator, plus the weight of the turbine runner and shaft, and the hydraulic thrust of the runner.

There is a four-panel black slate switchboard fitted with all the necessary indicating and recording instruments for the two generators, three out-going feeder-circuits, and an incoming 2300 v., 3-phase, supplied from the power-house of the Pacific Gas & Electric Co. There are also three motor-starter panels, one of which controls the 75-hp. induction-motor for driving the pumps that supply the prison water-system, another controls the 100-hp. motor which drives a compressor, and the third for controlling a 40-hp. motor used as a reserve-drive for the exciter. The air-compressor is mounted on an extension of the generator-floor, as is shown in the cross-sectional view. An illustration of the generator-floor is also shown, in which are the two generators, the belt-driven exciter, the governor, and the switch-board. The hydraulic turbines, with all jack-shaft mechanism, were furnished by the S. Morgan Smith Co. of York, Pennsylvania; the generators and exciters were furnished by the Allis-Chalmers Mfg. Cc.; the governing mechanism by the Woodward Governor Co.; the compressor by the Ingersoll-Rand Co.; and the switch-board by the General Electric Co. The entire plant was designed and installed under the supervision of Rudolph W. Van Norden, engineer, under the authority of State Department of Engineering, and the installation was handled by the labor of convicts at the State Prison.

## A LONG-LIVED WATER-TUBE BOILER

The first boiler built by the Heine Safety Boiler Co. was recently removed from the National Guard Armory at 18th and Pine streets, St. Louis, after 35 years of continuous service. It had 24 tubes about 10 ft. long, and a heating-surface of approximately 250 sq. ft., giving it a rating of 25 hp. It was designed for a pressure of 100 lb. An inspector from the Fidelity & Casualty Co. stated that after re-tubing, renewal of the blow-off flange, and the addition of new valves and trimmings, the boiler would be good for 80 lb. at the present time.

# Engineers' Note Book

## TABLE FOR REDUCING WEIR-MEASUREMENTS

The following table for reducing weir-measurements is taken from 'The Canadian Engineer.'

| Depth on crest, in. | Cu. ft. per sec. for each ft. in length | Miners' inches |
|---|---|---|
| 1 | 0.08 | 3.2 |
| 1½ | 0.15 | 6 |
| 2 | 0.23 | 9 |
| 2½ | 0.30 | 12 |
| 3 | 0.40 | 16 |
| 3½ | 0.50 | 20 |
| 4 | 0.65 | 26 |
| 4½ | 0.77 | 31 |
| 5 | 0.90 | 36 |
| 5½ | 1.04 | 42 |
| 6 | 1.18 | 47 |
| 6½ | 1.34 | 54 |
| 7 | 1.50 | 60 |
| 7½ | 1.66 | 66 |
| 8 | 1.81 | 72 |
| 8½ | 2.00 | 80 |
| 9 | 2.18 | 87 |
| 9½ | 2.35 | 94 |
| 10 | 2.55 | 102 |
| 10½ | 2.75 | 110 |
| 11 | 2.93 | 117 |
| 11½ | 3.15 | 126 |
| 12 | 3.35 | 134 |

## REPORT-CARD FOR STREET-WORK INSPECTORS

By FRED H. CHESTNUT*

The accompanying report-card has been prepared for inspectors on street-work in Burlingame. The following instructions appear on the back of the card:

Keep record of each class of work on a separate card.

Define the work by naming the street and the block between certain streets.

In reporting the quantity of cement used, a careful count of the sacks should be made during the progress of the work, checked by a re-count of the total for the day's run. Concrete aggregate should be estimated in the pile, verified by occasional accurate measurement. Sewer-pipe should be counted and the count verified by the total length laid each day. Reinforcement need not be measured, but the inspector should

*City engineer, Burlingame, California.

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see that the amount placed conforms to the requirements of the plans.

The previous day's work should be examined daily to see that the requirements of the specifications in regard to the care and protection of the work, have been followed.

It is the duty of the inspector to report immediately to the superintendent of streets, and to no other person, any apparent or alleged omissions or commissions, upon the part of the contractor, at variance with the plans and specifications.

Deal with the contractor in a courteous, fair, and business-like manner, bearing in mind that his business is to make as much money as he legitimately can under his contract, while the inspector is, primarily, to see that the work under construction is executed in a workmanlike manner and in strict accordance with plans, specifications, and cross-sections.

**INSPECTOR'S DAILY REPORT**

**Burlingame, Cal.**

**Job** ..... **Date** .....**191**....

**Nature of Work** .....

**Location of Work** .....

**MATERIALS USED**

| MATERIAL | BRAND OR TRADE NAME | AMOUNT |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

**LABOR** **Hours Worked**.....

| Class | NO. | Rate per H. | Class | NO. | Rate per H. |
|---|---|---|---|---|---|
| Foreman | | | Laborers 1st Class | | |
| Mechanics 1st Class | | | Laborers 2nd Class | | |
| Mechanics 2nd Class | | | | | |

**Has previous day's work been properly cared for?**.....

**Has this day's work been carried out in strict accordance with the plans and specifications?**.....

**If not, why not?**.....

.....

**Contractor** .....

**Foreman** ..... (Signature) **Inspector** ..... (Signature)

REPORT CARD FOR STREET INSPECTOR

Obtain a copy of the plans and specifications, and inform yourself of their scope, true intent, and meaning.

Remember that the most perfect system of rules, to insure success, must be interpreted upon the broad grounds of professional intelligence and common sense.

You have two eyes and one mouth; use them in that proportion.

## Book Reviews

BUSINESS LAW FOR ENGINEERS. By C. Frank Allen. Pp. 431. Index. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $3.

The author of this book is both an engineer and a lawyer, and would, apparently, 'qualify as an expert' in either profession. The book is divided into two parts, Part I dealing with the elements of law, while Part II is devoted to contract-letting. Besides the introduction, the chapter-headings in Part I are Evidence, Contracts, Torts, Equity, Real Property, Corporations, Agency, Sales, and Negotiable Instruments. There is also a chapter on the legal aspects of the construction and operation of railroads, and one on the engineer's legal relations with others. In this latter chapter the much-discussed question of expert testimony is considered. Part II takes up the various steps in the letting of contracts, including the Advertisement, Information for Bidders, Proposal, Contract Forms, Bond, and Specifications. The 'Uniform Contract Form' approved by the American Railway Engineering Association is given in full and discussed in detail, and this is also done with several other contract forms, including the one used for the 'cost-plus-percentage' contracts now the rule on work for the Federal Government. The chapter on specifications is general and does not attempt to give standard forms. In the preface, the purpose of the book is stated to be not to make 'every man his own lawyer,' but to place the engineer in a position to know when and how to act himself and when to seek legal advice. The book is well suited to accomplish this object.

PARALLEL TABLES OF SLOPES AND RISES. By Constantine K. Smoley. Pp. 330. Ill. McGraw-Hill Book Co., Inc., New York. For sale by *Mining and Scientific Press*, San Francisco. Price, $4.

The many draftsmen on bridge and building construction that have used Smoley's Tables, will welcome this additional volume, which contains some of the tables in the earlier volume and adds a great many more. The tables of slopes and rises are given for bevels varying by $\frac{1}{16}$ in., from $\frac{1}{16}$ in. to 12 in. per ft. The bases are given varying by $\frac{1}{16}$ in. up to 12 in. and by 1 ft. up to 40 ft. For each base and bevel the corresponding rise and hypothenuse are given. Some idea of the exhaustive nature of the tables may be gained from the statement that the solution of 100,000 right angles was required. Other tables give logarithms and squares by intervals of $\frac{1}{32}$ in. up to 10 ft. The text explains the use of the tables quite fully.

EXAMPLES IN BATTERY ENGINEERING. By F. E. Austin. Pp. 88. Ill., index. F. E. Austin, Hanover, New Hampshire. For sale by 'Mining and Scientific Press,' San Francisco. Price, $1.25.

The increasing use of primary and storage batteries is a sufficient reason for the publication of a book dealing with the construction and arrangements of such batteries. The theory as expounded is illustrated by a number of practical examples. While the electrical engineer naturally will find little that he does not know already, the book will be of value to the student and to the man without technical training who wishes to acquaint himself with this subject.

PROCEEDINGS OF THE FOURTEENTH ANNUAL CONVENTION OF THE AMERICAN ROAD BUILDERS' ASSOCIATION. Pp. 329. Index. The American Road Builders' Association, 150 Nassau street, New York. Price, $2.

This convention was held at Boston last February. The procedure appears to have come nearer to following a definite plan than at the ordinary highway convention. An entire session was devoted to each paper and the resulting discussion. In this way earth and gravel roads, bituminous pavements, concrete pavements, wood-block pavements, granite-block pavements, and brick pavements were considered. It is significant that practically no mention was made of water-bound macadam, which was considered the ideal country-road surface only a few years ago. Two other papers discussed the excavation and handling of materials, and the traffic census.

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## New Publications

GEOLOGY OF PORTION OF THE MCKITTRICK DISTRICT. A Typical Example of the West Side San Joaquin Valley Oil-Fields, and a Correlation of the Oil Sands of the West Side Fields. By G. C. Gester. Vol. VII, No. 9, Proceedings of the California Academy of Sciences, San Francisco. 21 pp., with inset maps and cross-sections of wells.

DETERIORATION IN THE HEATING VALUE OF COAL DURING STORAGE. By Horace K. Porter and F. K. Ovitz. Pp. 36. Ill., index. Bulletin No. 136, U. S. Bureau of Mines. Gives the results of experiments on several kinds of bituminous and semi-bituminous coal, both under water and exposed to the air.

EFFECTS OF STORAGE UPON THE PROPERTIES OF COAL. By S. W. Parr. Pp. 39. Ill. Bulletin No. 97, Engineering Experiment Station, University of Illinois, Urbana. Gives results of experiments upon several different kinds of bituminous coal, both under water and exposed to the air.

EVAPORATION FROM THE SURFACES OF WATER AND RIVER-BED MATERIALS. By R. B. Sleight. 53 pp., ill. Vol. X, No. 5, Journal of Agricultural Research, Washington, D. C. Discusses an investigation made at Denver, Colorado. More fully reviewed on page 465 of this issue.

WATERTIGHT CONCRETE. 22 pp., ill. The Hydrated Lime Bureau of the National Lime Manufacturers' Association, Pittsburgh, Pa. Describes several important engineering works on which hydrated lime was used in order to produce impervious concrete.

THE WAR REVENUE LAW OF 1917. The Federal Trade Information Service, Washington, D. C. 84 pp. Contains the text of the law and an explanation of its provisions. Price, 50 cents.

HYDRAULIC CONVERSION TABLES AND CONVENIENT EQUIVALENTS. Water-Supply Paper No. 425-C, U. S. Geological Survey, Washington, D. C. Useful tables for hydraulic engineers.

SHAPE BOOK OF CARNEGIE STEEL CO. 265 pp. Obtainable at district offices of the company. Price, $1.

## Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Section of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Wilkie Woodard, secretary, 435 Consolidated Realty building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

A meeting of the OREGON SOCIETY OF ENGINEERS was held November 15 at Portland. A. L. Barbour, commissioner of public works for the city of Portland, addressed the Society on 'Cost-Keeping in City Departments.'

A meeting of the San Francisco Section of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS was held November 23. M. M. O'Shaughnessy, city engineer of San Francisco, delivered an address on the 'Construction of the Hetch-Hetchy Project.'

A meeting of the ENGINEERS' CLUB OF THE OAKLAND CHAMBER OF COMMERCE was held on November 28. F. R. George addressed the club on 'The Conservation of Water-Power.'

## Personal

LEE R. COOKE has been appointed city engineer of Nampa, Idaho.

W. C. HAMMATT has been appointed engineer for the Medford, Oregon, irrigation district.

A. S. KALENBORN has been appointed electrical engineer and superintendent for the Cerro de Pasco Mining Company.

JOHN A. MCGREGOR has been appointed chairman of the executive committee of the Bethlehem Shipbuilding Corporation, Limited.

HUGH C. LEWIS has been appointed engineer for the United States Smelting, Refining & Mining Co., with headquarters at Eureka, Colorado.

MORTON MACARTNEY, formerly city engineer of Spokane, has resigned to become chief engineer for Porter Bros., general contractors.

GEORGE HAWLEY has been appointed resident engineer for the East Bay Water Co. in charge of the construction of the San Pablo dam.

HERMAN C. ALLEN has been appointed State highway engineer of Idaho, succeeding E. M. BOOTH, who resigned to enter the Federal service.

J. B. DAWSON has been appointed division engineer for the Southern Pacific Co., with headquarters at Stockton, succeeding G. W. CORRIGAN, who has been transferred to Bakersfield.

WILLIAM S. CONE and IRVING C. HARRIS have opened offices in the Hollingsworth Bdg., Los Angeles, under the name of Cone & Harris. They will engage in general engineering practice.

LESTER H. HIBBARD has left Los Angeles to accept a position with the Stone & Webster Engineering Corporation, in connection with the construction work this concern is doing in France for the Federal Government.

## Commercial Paragraphs

The INGERSOLL-RAND CO. has issued form No. 859, a 4-page pamphlet on the I-R pocket oil-flask; form 858, a pamphlet on steam-condensing plant; form No. 3118, a 32-page pamphlet on compressors and vacuum-pumps for the extraction of gasoline from natural gas; and form No. 4302, a 20-page pamphlet on Sergeant rock-drills.

The GENERAL ELECTRIC CO. has issued bulletin No. 41021 describing the R. F. adjustable-speed motors, and bulletin No. 46030 describing portable transformers. The company has also prepared an index to supply-parts and an index to other descriptive bulletins and sheets that it issues.

The STANDARD OIL CO. has issued bulletin No. 8, on the use of calol asphaltum in pavement construction, including a discussion of mixing-plants that will be useful to municipal and highway engineers.

The CLEVELAND MILLING MACHINE CO. issues a monthly 'Stock List of Milling Cutters' that will be found useful by machine-shop owners.

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# Construction News Summary

## STREET AND ROAD WORK

ASTORIA, ORE.—Contract for construction of ¾ mile of highway near Vesper has been awarded to W. E. and J. F. Johnson for $3379.50.

BELLINGHAM, WASH.—Contract for paving South Elk and 10th streets has been awarded to H. B. Peterson for $6826.

FRESNO, CAL.—Bids will be received until December 10 by D. M. Barnwell, county clerk, for construction of part of Millwood road near Squaw Valley, and for construction of the Shaver-Big Creek road.

Contract for improvement of Franklin avenue has been awarded to Thompson Bros., at the following unit prices; grading, $0.02 per sq. ft.; concrete sidewalks, $0.13 per sq. ft.; concrete curbs, $0.45 per ft.; oiling, $0.02 per sq. ft.; 6 by 18-in. corrugated culverts, $2.50 per ft.; 6 by 24-in. corrugated culverts, $3 per foot.

GLENDALE, CAL.—Contract for grading and macadamizing part of Milford street has been awarded to Conwell & Henderson, Glendale, for $2700.

HILLSBOROUGH, CAL.—Contract for improvement of Barroilhet avenue and Milford avenue has been awarded to Federal Construction Co., Sharon Bdg., San Francisco, for $3595. Raisch Improvement Co. bid $3668 and Blanchard-Brown Co. $4121.

LA JOLLA, CAL.—Contract for paving several streets has been awarded to Thomas C. Breitenstein for $54,496.

LOS ANGELES, CAL.—Board of Supervisors will receive bids until December 17 for construction of 0.65 mile of macadam pavement on Doheny drive.

Contract for improvement of 10th street has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $34,044.44.

Contract for construction of 0.63 mile of concrete pavement on Azusa avenue has been awarded to Redondo Construction Co., Redondo, for $18,500.

Contract for grading and paving Exposition boulevard has been awarded to George R. Curtis, 2440 East 26th street, Los Angeles, for $16,757.93.

Contract for grading and paving Hoover street has been awarded to Bryant & Austin for $18,587.07.

MARTINEZ, CAL.—County surveyor R. R. Arnold has been instructed to prepare plans for division No. 7 of county highway system, between Antioch and Oakley. It is intended to construct this division and division No. 8, between Pittsburg and Bay Point, during 1918.

OAKLAND, CAL.—Realty Syndicate Co. has awarded contract for street improvements at Chevrolet park to Bates, Borland & Ayer, Oakland Bank of Savings Bdg., Oakland, at the following unit prices: grading, $0.015 per sq. ft.; redwood curbs, $0.11 per ft.; 4-in. concrete pavement, $0.10 per sq. ft.; concrete sidewalks, $0.105 per sq. ft.; 8-in. sewer, $0.55 per ft.; manholes, $45 each; lampholes, $10 each; corrugated culverts, $3 per ft.; cast-iron culverts, $3.50 per foot.

Contract for extension of East 14th street through Castro valley to Dublin road has been awarded to Russell & Fernandez for $82,861.

OLYMPIA, WASH.—State Highway Commission will receive bids until December 10 for clearing, grading, and draining five miles of the Pacific highway in Cowlitz county, and for widening the embankment and changing the tracks of the Spokane, Portland & Seattle Railroad in Skamania county. This latter work will require 30,000 cu. yd. excavation.

OXNARD, CAL.—Contract for construction of one mile of bitucrete pavement has been awarded to E. M. Chadbourne, 503 Market street, San Francisco.

PASADENA, CAL.—Contract for grading and paving part of Holly street has been awarded to Bryant & Austin, 1656 Compton avenue, Los Angeles, for $15,967.02.

Contract for improvement of Franklin avenue has been awarded to J. E. Haddock, 357 North Chester street, Pasadena, for $5246.50.

PORTLAND, ORE.—State Highway Commission has awarded contract for construction of Wolf creek-Graves creek highway in Josephine county to American Exploration & Contracting Co. for $56,947.90.

State Highway Commission has completed plans for grading and macadamizing 10.6 miles of Pacific highway through Cow Creek canyon. U. S. Forest Service will pay part of cost.

REDWOOD CITY, CAL.—Contract for improvement of ½ mile of Mission road near South San Francisco has been awarded to Blanchard-Brown Co., San Francisco, the only bidder, at $6325.34.

RIVERSIDE, CAL.—State Highway Commission and the supervisors of the counties interested have agreed to construct highway from Indio to Kane Springs, 51 miles. This is part of the proposed highway from San Bernardino to Yuma. Riverside county will contribute $120,000 toward the cost, Imperial county $167,000, and the State $154,000, making a total of $441,000.

Plans have been completed and call for bids will be issued soon for construction of 28 miles of highway in the Palo Verde valley.

SACRAMENTO, CAL.—Blanchard-Brown Co., San Francisco, was low bidder and was awarded the contract for placing 31,700 sq. yd. of asphaltic wearing surface on State highway between Fresno and Malaga at $0.72 per sq. yd. or a total of $22,824 for type A. Other bidders were: Worswick Street Paving Co., type A, $23,775, type B, $25,677; Federal Construction Co., type A, $39,625, type B, $41,210; Clark & Henery Construction Co., $48,501 for either type; California Road & Street Improvement Co., type A, $51,354, type B, $51,988; Thompson Bros., type A, $51,354, type B, $52,939. Engineers' estimate was $25,518.50 for either type.

A. L. McCray, Los Angeles, was low bidder and was awarded the contract for construction of 10 miles of State highway between San Fernando and Rancho Tujunga in Los Angeles county at the following unit prices: excavation, $0.40 per cu. yd.; 18-in. corrugated-metal pipe, $2 per ft.; 24-in. pipe, $2; concrete in culverts and monuments, $16 per cu. yd.; concrete in pavement, $6; guard-rail, $1 per ft.; monuments, $1 each; a total of $111,251. Other bidders were: Fred Hoffman, $117,275.50; George R. Curtis, $141,135.50. Engineers' estimate was $92,236.04. State will furnish pipe-railing for culverts, reinforcing steel, corrugated pipe, cement, and asphaltic surfacing, valued at $39,422.50.

Palmer & McBryde, San Francisco, were low bidders and were awarded contract for construction of 15.6 miles of State highway between Garberville and Miranda in Humboldt county at the following unit prices: excavation, $0.715 per cu. yd.; 12-in. pipe, 0.60 per ft.; 18-in. pipe, $0.70; 24-in. pipe, $0.80; 30-in. pipe, $0.90; concrete in culverts and monuments, $15 per cu. yd.; concrete in retaining-walls, $14; moving and resetting property fences, $225 per mile; monuments, $1 each; a total of $223,555.70. Other bidders were: A. J. Fairbanks, $241,341.50; Warren A. Bechtel, $271,953; Bates, Borland & Ayer, $283,818; Shattuck-Edinger Co., $338,620.70. Engineers' estimate was $223,793.91. State will furnish pipe-railing, reinforcing-steel, corrugated pipe, and cement, valued at $27,077.80.

Palmer & McBryde, San Francisco, were the only bidders for construction of 3 miles of State highway in Monterey county near King City bridge, at the following unit prices: excavation, $0.90 per cu. yd.; 12-in. pipe, $0.90 per ft.; 18-in. pipe, $1; concrete in culverts and monuments, $18 per cu. yd.; concrete in pavement, $6; guard-rail, $0.50 per ft.; monuments, $1.50; a total of $42,359. Engineers' estimate was $34,042.88. State will furinsh pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $22,539.20. Bid was rejected and work will be re-advertised.

A. J. Fairbanks, Willits, was low bidder and was awarded the contract for construction of 9 miles of state highway in Nevada county between the southerly boundary and Rattlesnake creek, at the following unit prices: excavation, $0.87 per cu. yd.; 12-in. pipe, $0.70 per ft.; 18-in. pipe, $1; 24-in. pipe, $1.50; concrete in culverts and monuments, $22 per cu. yd.; monuments, $1.50; a total of $83,221.60. Robert Sherer & Co. bid $85,268.40 and Palmer & McBryde, $114,507.20. Engineers' estimate was $85,590.82. State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $5343.90.

W. A. Dontanville, Los Alamos, was low bidder for construction of 12 miles of state highway between the Santa Maria river and Arroyo Grande in San Luis Obispo county, at the following unit prices: excavation, $0.80 per cu. yd.; 12-in.

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pipe, $0.90 per ft.; 18-in., 24-in., and 30-in., $1; 36-in., $1.50; concrete in culverts and monuments, $12 per cu. yd.; concrete in pavement, $4.95; dry-rubble masonry, $9 per cu. yd.; guard-rail, $0.50 per ft.; monuments, $1.50; a total of $138,249.85. Tibbitts-Pacific Co. bid $165,748.45. Engineers' estimate was $121,241.63. State will furnish pipe-railing, reinforcing-steel, corrugated pipe, cement, sand, and coarse aggregate, valued at $107,771.

Bids will be received until December 10 by E. F. Pfund, county clerk, for construction of 13 miles of highway on the Sacramento River levee near Grand Island.

State Highway Commission has reached agreement with the interested counties to construct state highway lateral from Hanford to San Lucas by way of Coalinga. Total estimated cost is $1,502,538, which will be divided as follows: State of California, $500,000; Fresno county, $425,842; Kings county, $205,060; Monterey county, $370,890.

SAN BERNARDINO, CAL.—State Highway Commission will take over highway from San Bernardino to Cajon summit and will spend $100,000 on continuation of highway to Barstow.

SAN DIEGO, CAL.—Contract for construction of six miles of concrete highway from San Diego to Camp Kearny has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $108,325.

Contract for improvement of streets in La Mesa district has been awarded to Fairchild-Gilmore-Wilton Co. for $17,137.21.

SAN FRANCISCO, CAL.—Contract for improvement of Silver avenue has been awarded to J. F. Dowling at the following unit prices: concrete curbs, $0.85 per ft.; concrete sidewalks, $0.15 per sq. ft.; brick manholes, $90 each; brick catch-basins, $95 each; asphalt pavement, $0.225 per sq. ft.; 10-in. vitrified-pipe culvert, $1.50 per foot.

Contract for improvement of Naples street has been awarded to Flinn & Treacy at $0.90 per ft. for concrete curbs, and $0.26 per sq. ft. for asphalt pavement.

Contract for improvement of Teddy avenue has been awarded to J. F. Dowling at the following unit prices: excavation, $0.50 per cu. yd.; embankment, $0.10 per cu. yd.; concrete curbs, $0.75 per ft.; asphalt pavement, $0.235 per square foot.

Contract for improvement of Poplar street has been awarded to T. A. Clark at the following unit prices: excavation, $1 per cu. yd.; asphalt pavement, $0.24 per sq. ft.; re-setting granite curbs, $0.30 per foot.

Contract for improvement of Rutland street has been awarded to Ehrhart & Greely at the following unit prices: excavation, $0.75 per cu. yd.; embankment, $0.90 per cu. yd.; asphalt pavement, $0.23 per sq. ft.; concrete curbs, $0.75 per foot.

Contract for improvement of Greenwich street has been awarded to Fay Improvement Co. at the following unit prices: excavation, $1.55 per cu. yd.; embankment, $0.12 per cu. yd.; asphalt pavement, $0.245 per sq. ft.; vitrified brick pavement, $0.42 per sq. ft.; granite curbs, $1.18 per ft.; concrete sidewalks, $0.135 per sq. ft.; armored concrete coping, $0.75 per foot.

Contract for paving on pier 46 has been awarded to A. J. Raisch, Underwood Bdg., San Francisco, for $9030.80. Fay Improvement Co. bid $9697.72 and Flinn & Treacy, $11,354.90.

Bids will be received until December 6 by H. H. Cosgriff, secretary State Board of Harbor Commissioners, Ferry Bdg., for construction of pavement on the Embarcadero, requiring taking up and re-laying 49,130 sq. ft. of basalt block, paving 670 sq. ft. with new blocks, paving 3350 ft. with 4-in. bituminous concrete on crushed-rock base, paving 1440 sq. ft. with new basalt blocks on concrete base, 54,330 sq. ft. with 3-in. bituminous concrete on concrete base, and laying 10,480 sq. ft. of sidewalk.

Contract for improvement of part of Hunters Point road has been awarded to H. Crummey, Inc., Hearst Bdg., San Francisco, at the following unit prices: excavation, $0.50 per cu. yd.; embankment, $0.25 per cu. yd.; asphalt pavement, $0.20 per sq. ft.; granite curbs, $1 per ft.; brick manholes, $85 each; brick catch-basins, $87 each; 10-in. vitrified pipe culverts, $1 per ft.; 21-in. sewer, $3 per ft.; 12-in. sewer $2.25 per ft.; 8-in. sewer, $2 per ft.; wye-branches on 12-in. sewer, $2 each; wye-branches on 8-in. sewer, $1.50 each.

Contract for improvement of Arleta avenue has been awarded to F. R. Ritchie, Chronicle Bdg., San Francisco, at the following unit prices: excavation, $0.85 per cu. yd.; embankment, $0.50 per cu. yd.; concrete curbs, $0.75 per ft.; concrete sidewalks, $0.15 per sq. ft.; 10-in. vitrified-pipe culverts, $1.25 per ft.; asphalt pavement, $0.22 per sq. ft.; brick catch-basins, $75 each.

Contract for improvement of Balboa street has been awarded to J. G. Harney, Pacific Bdg., San Francisco, at the following unit prices: concrete curbs, $0.80 per ft.; concrete sidewalks, $0.12 per sq. ft.; asphalt pavement, $0.225 per sq. ft.; basalt-block header pavement on concrete foundation, city to furnish blocks, $0.10 per sq. ft.; 10-in. vitrified-pipe culvert, $1.50 per ft.; brick catch-basins, $85 each.

SAN PEDRO, CAL.—Contract for construction of pavement on Miner fill for the Outer Harbor & Dock Co. has been awarded to Fairchild-Gilmore-Wilton Co. for $10,150.

SANTA ANA, CAL.—Steele Finley was low bidder at $4582 and was awarded the contract for construction of concrete pavement at San Juan Capistrano. Orange County Engineering & Construction Co. bid $4972.20.

Wells & Bressler were low bidders at $1152 and were awarded the contract for paving west approach to Olive bridge. A. G. Wright bid $1480.

Steele Finley was low bidder at $3323.20 for construction of concrete pavement at Buena Park. Other bidders were: Fred Hoffman, $3646.96; Orange County Engineering & Construction Co., $3897; J. S. Miller, $4138.32; A. G. Wright, $4742.40. All bids were rejected.

SANTA BARBARA, CAL.—Contract for paving part of State street has been awarded to G. R. Curtis, Los Angeles, for $5163.39. A. L. Pendola bid $6473.63.

Contract for paving another part of State street has been awarded to A. L. Pendola for $1215.18. G. R. Curtis bid $1316.44.

Contract for grading and construction of concrete curbs and gutters on Islay street has been awarded to E. H. Hunt, Santa Barbara, for $2031. A. L. Pendola bid $2566.83. Engineer's estimate was $1859.

Contract for paving Canyon Perdido street has been awarded to A. L. Pendola, Santa Barbara, for $1465.85. G. R. Curtis bid $1501.49.

Contract for improvement of State street has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $37,835.24. This contract was awarded once before to the same company, but, on account of technicality, a new call for bids was issued.

SANTA CRUZ, CAL.—No bids were received by Board of Supervisors for improvement of Boulder Creek road between Santa Cruz and Felton, and work will be done by day-labor under the supervision of county surveyor Lloyd Bowman.

SANTA MONICA, CAL.—Contract for paving Central avenue has been awarded to Frank Ockert for $30,739. M. W. McComb bid $30,719.72, but his bid was irregular.

SEATTLE, WASH.—Contract for paving 6th avenue South has been awarded to McGuire Bros., American Bank Bdg., Seattle, for $33,825.

UKIAH, CAL.—Stoddard, Buchanan & Lane were the only bidders at $15,000 for construction of Elk Creek-Greenwood road. Bid was rejected because too high, and work will be done by day-labor.

VISALIA, CAL.—Federal Construction Co., San Francisco, was low bidder at 19.5c. per sq. ft. for construction of pavement on East Mineral King avenue. All bids were rejected and work has been postponed indefinitely.

WAPATO, WASH.—Contract for paving several streets has been awarded to Washington Paving Co., L. C. Smith Bdg., Seattle, for $28,583.

YREKA, CAL.—Contract for reconstruction of Scott River Canyon road has been awarded to L. W. Cousins for $4400. Fred S. Henderson and I. B. Mathews bid $4975.59 and Albert Anderson & Co. bid $7540.

## SEWERS AND DRAINAGE

FRESNO, CAL.—Bids will be received until December 17 by W. H. Ryan, city clerk, for construction of addition to septic tank at sewer-farm.

GLENDALE, ARIZ.—Contract for construction of sewer system has been awarded to Claude Fisher & Co., Phoenix, for $46,707.20, using cement pipe.

LIND, WASH.—Contract for construction of sewer system has been awarded to J. B. Romano, 3314 16th avenue, Seattle, for $48,450.

SACRAMENTO, CAL.—Bids will be received until December 7 at office of reclamation district No. 1500, California Fruit Bdg., Sacramento, for construction of lateral drainage canals requiring between 546,600 cu. yd. and 1,375,800 cu. yd. excavation. Of this amount 2% is team-and-scraper work, 22% can be done with either a floating dredge or a drag-line excavator, depending upon water conditions, and 76% can be done with an excavating machine. The work is in the Sutter basin.

State Reclamation Board has approved plans for construction of drainage ditch on lower Cosumnes river. Estimated cost is $10,000.

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SAN FRANCISCO, CAL.—Contract for construction of sewer on Redondo street has been awarded to P. A. Belser at $3 per ft. for 18-in. vitrified-pipe sewers, $2.50 each for wye-branches, and $75 each for manholes.

Contract for construction of sewer on Greenwich street has been awarded to Fay Improvement Co. at the following unit prices: 8-in. vitrified-pipe sewer, $4.35 per ft.; wye-branches, $2 each; brick manholes, $94 each.

Contract for construction of sewer on Newcomb avenue has been awarded to J. H. Franks at the following unit prices: 8-in. vitrified-pipe sewer, $1.50 per ft.; 6-in. sewer, $0.80 per ft.; wye-branches, $0.70 each; brick man-holes, $68 each.

Contract for construction of sewer on Caselli avenue has been awarded to T. S. Hutton, Call Bdg., San Francisco, at $4.95 per ft. for 18-in. vitrified-pipe sewer, and $3.50 each for wye-branches.

SANTA ANA, CAL.—Formation of drainage district containing 50,000 acres of land in vicinity of Buena Park is proposed. Estimated cost of work is $250,000. J. N. Anderson, Santa Ana, and A. Nelson, Buena Park, are interested.

SANTA BARBARA, CAL.—W. M. Ledbetter, Pacific Electric Bdg., Los Angeles, was the only bidder at $33,341 for construction of sewer-disposal plant.

W. M. Ledbetter was the lowest bidder at $37,942 for construction of outfall sewer. Mercereau Bridge & Construction Co. bid $38,638.

Mlagenovich & Gillespie, 219 Bloom street, Los Angeles, were the lowest bidders at $36,325 and were awarded the contract for construction of intercepting sewer. W. A. Frick and John Ukropina bid $37,198.

All bids for construction of outfall sewer and sewage-disposal plant have been rejected because too high.

State Board of Health has approved modified plans for sewage-disposal plant, providing for screens instead of septic tank. This will permit construction of entire system with the money available. Call for bids for construction of outfall sewer and screen-disposal plant will be issued soon. Olmsted & Gillelen, Hollingsworth Bdg., Los Angeles, are engineers. Estimated cost of work is $50,000.

STOCKTON, CAL.—Haviland & Tibbetts, Alaska Commercial Bdg., San Francisco, have been engaged to prepare plans for sewage-disposal works and sewage-pumping plant.

UPLAND, CAL.—Contract for construction of outfall sewer has been awarded to Joe Chutuk, Los Angeles, for $18,118.90, using cement pipe. His bid on vitrified pipe was $18,818.90.

## BRIDGES AND CULVERTS

EUREKA, CAL.—Bide will be received until December 11 by Fred M. Kay, county clerk, for construction of cable suspension bridge across Mad river near Mountain View.

County surveyor A. J. Logan has completed plans for steel suspension bridge across Eel river at Alderpoint, and call for bids will be issued soon. Estimated cost is $45,000.

FRESNO, CAL.—Contract for construction of the North Reedley bridge has been awarded to J. E. Mitchell, 201 N street, Fresno, for $3590.

OAKLAND, CAL.—Plans for bascule bridge across Oakland estuary submitted by Harrington, Howard & Ash, Kansas City, Missouri, have been approved.

Contract for construction of reinforced concrete culvert 5.25 ft. high and 7 ft. wide on 40th avenue has been awarded to Hutchinson Co., Oakland, at $19.95 per ft. for the culvert, $0.40 per cu. ft. for concrete in retaining-walls, and $5 each for concrete curtain-walls.

RIVERSIDE, CAL.—Contract for construction of wooden bridge across Potrero creek has been awarded to W. U. Sharp, Riverside, for $1960.

SACRAMENTO, CAL.—Bids will be received until December 10 by E. F. Pfund, county clerk, for construction of highway-bridge in fifth district.

Bids for construction of concrete bridge on county highway near Galt have been rejected.

SAN FRANCISCO, CAL.—Bids will be received until December 6 by State Board of Harbor Commissioners for construction of steel viaduct across Embarcadero at Market street.

SAN JOSE, CAL.—Contract for construction of reinforced concrete bridge over Smith creek on Mt. Hamilton road has been awarded to John Doyle for $4487. Sam Sciarrino bid $4990. Engineer's estimate was $4600.

Election will be held on December 18 to vote on diversion of unexpended balance of $49,000 of outfall sewer fund for construction of Coyote River bridge at Santa Clara street.

SANTA ROSA, CAL.—Contract for construction of two wooden bridges and a short stretch of connecting road at Bodega has been awarded to F. J. Riddell, Bodega, for $2280.

Contract for construction of concrete trestle on Santa Rosa-Penngrove road has been awarded to W. L. Proctor for $5766.

Contract for construction of concrete bridge on Healdsburg-Calistoga road has been awarded to Bailey-Comstock Co. for $1100.

SONORA, CAL.—Contract for construction of reinforced concrete bridge ocress Rattlesnake creek near Priest's Station has been awarded to A. M. Gookin for $1280.

## IRRIGATION AND WATER SUPPLY

BAY POINT, CAL.—Contract for construction of reservoir for Bay Point Light & Water Co. has been awarded to Lindgren & Co., Monadnock Bdg., San Francisco.

BREMERTON, WASH.—W. B. Lance, Northern Bank Bdg., Seattle, was low bidder at $39,456.25 and was awarded the contract for construction of concrete reservoir for water system.

HANFORD, CAL.—Lake Land Canal & Irrigation Co. will spend $25,000 on improvement of system. F. R. Hight, 620 North Irwin street, Hanford, is secretary.

SALT LAKE CITY, UTAH.—V. A. Bettilyon has applied to State engineer for permission to divert 52 second-feet of water from Jordan river for irrigation. Canal 10 miles long will be constructed.

SAN FRANCISCO, CAL.—State Water Commission has received the following applications for permission to divert water:

J. N. Tedford, Red Rock, 2215 acre-feet from creek in Lassen county. Plans include rock and earth dams with rip-rap face. Estimated cost is $18,000.

E. G. Hopson, Portland, 29.6 second-feet from creek in Shasta county for irrigation. Plans include rock-filled timber-crib dam, wooden flume, wood-stave pipe-line, and canal. Estimated cost is $100,000.

J. G. Buddle, Snelling, 20 second-feet from Merced river for irrigation. Plans include dam, centrifugal pumps and motors, and canal. Estimated cost is $10,000.

Long Valley irrigation district, 50 second-feet from Little Truckee river for irrigation.

Elliott Land Co., San Francisco, 35 second-feet from San Joaquin river and 35 second-feet from Stanislaus river for irrigation.

Coachella Power & Irrigation Co., through F. H. Merrill and W. B. Baker, of Los Angeles, water from Whitewater river for irrigation and power. Estimated cost of work is $4,900,000.

State Water Commission has issued the following permits to divert water:

Lora J. Moore, Tahoe City, ½ second-foot from tributary of Lake Tahoe for power. Plans include rubble dam. Estimated cost is $10,000.

Blevins-Mallon Ditch Co., Colusa, 142 second-feet from Sacramento river for irrigation. Plans include one 36-in., one 30-in. and two 18-in. centrifugal pumps, all direct-connected to electric motors, and a main canal 8½ miles long. Estimated cost is $80,000.

A. F. Wohlfram, Colusa, 16 second-feet from Sacramento river for irrigation. Plans include electrically driven pumping-plant costing $11,000.

SEATTLE, WASH.—Contract for laying cast-iron water-mains on 10th avenue and other streets has been awarded to Scalzo & Co. for $47,327.

STOCKTON, CAL.—Holt Mfg. Co. will construct water-tower, piping system, and other fire-fighting equipment. Estimated cost is $50,000.

TORRINGTON, WYO.—Bids will be received until December 18 at office of U. S. Reclamation Service, for construction of 15.7 miles of canals, requiring 236,700 cu. yd. excavation. Work is near Torrington. Particulars from U. S. Reclamation Service, Washington, D. C., Denver, or Torrington. Detailed specifications on file at office of 'Western Engineering.'

VALLEJO, CAL.—F. H. Tibbetts, Alaska Commercial Bdg., San Francisco, has reported that construction of additional reservoir for city water supply in Green valley will cost $200,000, including price of land. Reservoir would have a capacity of 273,000,000 gal. and a safe draft of 624,000 gal. per day.

WATERFORD, CAL.—Waterford irrigation district has awarded the following contracts for building timber and concrete structures on canals:

Sections No. 19, 20, and 24 to R. Von Voorheis for $6310.95.

Sections No. 22, 23, and 25 to D. E. Kilroy for $6646.

On sections No. 26, 27, 28, and 29, M. Blumenkranz, Stockton, was the only bidder at $21,168.20. Bid was rejected.

Dawald & Collins bid $2180.76 on section 22.

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### LIGHT, HEAT, AND POWER

COLMA, CAL.—Contract for construction of hot-water heating plant for Holy Cross Cemetery has been awarded to Neil H. Dunn, San Francisco, for $1495.

SAN FRANCISCO, CAL.—Following bids were received for construction of heating system in branch county-jail: J. E. O'Mara, $5166 (awarded contract); A. Lettich, $5207; Scott Co., $5660; R. Dalzier, Jr., $5697; Wittman-Lyman Co., $5994.

Contract for installing electric conductors and appurtenances on the Market Street municipal railroad between the east portal of the Twin Peaks tunnel and Church street and between Van Ness avenue and Geary street has been awarded to H. S. Tittle, San Francisco.

Contract for lighting fixtures in south-east wing of San Francisco Hospital has been awarded to Thomas Day Co., San Francisco, for $7547.

State Water Commission has received the following applications for permission to divert water:

Fresno Flume & Lumber Co., Clovis, 200 second-feet from Dinkey creek and 400 second-feet from Big creek for power. Plans include storage-reservoir, and ditches, tunnels, and pipelines 12½ miles long.

Paul J. Stuparich, Middletown, 8 miners' inches from stream in Lake county for power. Plans include pipe-line, reservoir, and Pelton wheel.

SEATTLE, WASH.—Contract for furnishing transformers to city light department has been awarded to W. R. Hendry & Co., for $55,778.94.

WOODLAND, CAL.—Contract for furnishing and installing electric fixtures in court-house has been awarded to Roberts Manufacturing Co., San Francisco, for $11,300. Thomas Day Co. bid $12,250 and L. J. Meyberg $12,630.

YUMA, ARIZ.—Southern Sierras Power Co. will build transmission-line from Yuma to mines at Ajo, 160 miles.

### RIVER AND HARBOR WORK

BLYTHE, CAL.—J. C. Allison, Calexico, engineer for Palo Verde levee district, has submitted an estimate of $1,285,000 for the cost of completion of the levee system of the district.

EL CENTRO, CAL.—Bids will be received until December 14 by Imperial irrigation district for raising and widening the Volcano Lake and the Salz levees, requiring the moving of 555,000 cu. yd. and 240,000 cu. yd., respectively. This is steam-shovel work.

LONG BEACH, CAL.—Contract for construction of reinforced concrete sea-wall on Seaside boulevard has been awarded to Mercereau Bridge & Construction Co., Pacific Electric Bdg., Los Angeles, for $76,400.

Contract for dredging in harbor has been awarded to Los Angeles Dredging Co. for $35,000.

OAKLAND, CAL.—C. Christensen & Sons, 565 16th street, Oakland, were awarded contract at $22,800 for construction of a shed on the municipal wharf at Clay street. Bert T. Owsley bid $24,949.

SACRAMENTO, CAL.—Contract for construction of concrete revetment and timber toe-wall for levees of reclamation district No. 744 on Sacramento river has been awarded to Duncanson-Harrelson Co., Chronicle Bdg., San Francisco, for $20,451.75.

State Reclamation Board has levied assessment of $14,993,190 on lands included within the Sacramento River Flood-Control project. Of this amount, $7,099,637.60 will be used for the construction of the Sutter by-pass, $799,225.47 for the Tisdale by-pass, $996,621.65 for drainage-works for water intercepted by the east levee of the Sutter by-pass, $649,704.57 for the Butte Slouth by-pass, and $5,264,437.20 for the Butte by-pass.

SAN FRANCISCO, CAL.—Bids will be received until December 16 at U. S. Engineer Office, 401 Custom House, for dredging in Oakland harbor.

Plans have been completed and call for bids will be issued soon by State Board of Harbor Commissioners for the following work:

Mill-construction and concrete shed on pier No. 3, area 100,000 sq. ft., together with bulkhead-wharf.

Mill-construction shed on pier 41, area 140,000 square feet.

Concrete bulkhead-wharf, 2150 ft. long at China basin.

Fred C. Franks, Phelan Bdg., San Francisco, was low bidder at $0.1789 per cu. yd. for dredging on San Joaquin river.

### RAILROAD WORK

BENSON, ARIZ.—Southern Pacific Co. will make changes in grade and alignment in this vicinity, requiring several concrete bridges and considerable grading. Estimated cost is $70,000. Work will be done by day-labor.

JEROME, ARIZ.—Contract for grading about four miles of extension of Verde Tunnel & Smelter railroad has been awarded to Twohy Bros. Co., San Francisco.

POCATELLO, IDA.—Oregon Short Line will construct branch railroad from Keever to Thomas, 4.55 miles, estimated cost $99,100, and line from Collins north-west, 7.26 miles, estimated cost, $143,200.

QUINCY, CAL.—Quincy Western railroad will be sold to syndicate in which Quincy Lumber Co. is interested, and operation of the road will be continued.

SAN DIEGO, CAL.—San Diego & South Eastern Railroad is preparing plans for construction of electric railroad from Lakeside to Santa Ysabel.

San Diego & Arizona Railroad and San Diego & South Eastern Railroad have been consolidated. Extensions will be made.

SAN FRANCISCO, CAL.—State Railroad Commission has authorized Clear Lake Railroad Co. to issue $500,000 in bonds and $152,900 in common stock for construction of railroad from Hopland to Lakeport. Guy L. Hardison, Rialto Bdg., San Francisco, has contract for construction of line, payment to be made in bonds.

SAN JOSE, CAL.—Western Pacific Railway Co. has awarded contract for construction of San Jose terminal of its line from Niles to San Jose, 23 miles, to Palmer & McBryde, San Francisco. Contract for construction of remainder of line has been awarded to Utah Construction Co., San Francisco.

### BUILDING CONSTRUCTION

BERKELEY, CAL.—Contract for construction of aviation barracks for University of California has been awarded to Alfred Olsen, 565 16th street, Oakland, for $15,000.

BURLINGAME, CAL.—Contract for construction of class C building for garage has been awarded by Peninsula Rapid Transit Co. to Lange & Bergstrom, Sharon Bdg., San Francisco, for $19,500.

CORNING, CAL.—Dickey & Donovan, 414 13th street, Oakland, are preparing plans for frame hotel-building for W. N. Wodson. Estimated cost is $70,000.

DALY CITY, CAL.—Contract for construction of school-building has been awarded to P. P. Quinn for $22,680.

EL CENTRO, CAL.—Contract for construction of jail has been awarded to P. L. Hedrick and James Milburn, El Centro, for $24,974. Contract for steel work has been awarded to Brombacher Iron Works, Los Angeles, for $19,983.

EUGENE, ORE.—Contract for construction of hospital-building has been awarded to John Almeter, Portland, for $80,000.

EUREKA, CAL.—W. C. Duncan & Co., Sharon Bdg., San Francisco, were low bidders for construction of reinforced concrete building for Home Savings Bank.

FRESNO, CAL.—Contract for construction of building for Kirk school has been awarded to James L. Daly, Fresno, for $35,980. Contract for construction of heating system has been awarded to J. C. Hurley Co., San Francisco, for $7107.

Contract for construction of building for Fresno Natatorium Co. has been awarded to James L. Daly, Fresno, for $33,100.

HERCULES, CAL.—J. T. Narbett, Richmond, is preparing plans for frame building for Hercules Powder Co. Estimated cost is $15,000.

JEROME, ARIZ.—Lescher & Kibbey, Bank of Arizona Bdg., Phoenix, are preparing plans for reinforced concrete hotel-building costing $75,000 and for reinforced concrete apartment-house costing $50,000. Both buildings are for United Verde Mining Company.

LOS ANGELES, CAL.—Contract for repairing class C building for P. M. Johnson has been awarded to B. F. Yarnell, 219 South Union avenue, Los Angeles, for $20,000.

State Railroad Commission has held a hearing to discuss plans for proposed union railroad terminal. One plan provides for remodeling the Arcade station of the Southern Pacific Co. to accommodate the Salt Lake Route and the Pacific Electric Railroad as well, at an estimated cost of $3,680,000. Another plan calls for the construction of a terminal at the Plaza to accommodate the Southern Pacific Co., Santa Fe Railroad, Salt Lake Route, and Pacific Electric Railroad, at an estimated cost of $10,000,000.

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OAKLAND, CAL.—Contract for construction of one-story steel-frame machine-shop for Moore & Scott Iron Works has been awarded to P. J. Walker Co., Monadnock Bdg., San Francisco, for $65,000.

Contract for construction of machine-shop for Union Iron Works has been awarded to W. C. Duncan & Co., San Francisco, for $140,115.

Contract for construction of frame and plaster apartment-house has been awarded to W. C. Heyer, Dalziel Bdg., Oakland, for $35,000.

W. G. Thornally, 3027 16th street, Oakland, was low bidder and was awarded the contract at $52,985 for construction of additions to county tuberculosis hospital at Livermore. Other bidders were: C. W. Heyer, Jr., $54,800; Schnebly & Hostrawser, $55,520; E. T. Leiter & Son, $58,987.

Contract for excavation and concrete work for building for Pacific Telephone & Telegraph Co. has been awarded to Palmer & Petersen for $15,300.

OLYMPIA, WASH.—Contract for construction of State building at Orting has been awarded to Ferro-Concrete Construction Co., Empire Bdg., Seattle, for $26,985.

PALO ALTO, CAL.—Following contracts were awarded for construction of high-school buildings: excavation, E. A. Hettinger, Palo Alto, $2427; concrete work, E. A. Hettinger, $21,756; masonry work, C. L. Wold Co., San Francisco, $25,734; carpentry work, C. L. Wold Co., $54,288; sheet-metal work, Cashel Bros., Palo Alto, $2150; tile roofing, United Materials Co., San Francisco, $8650; composition roofing, Santa Clara Valley Roofing Co., $520; plastering, J. C. McLeod, San Francisco, $11,369; blackboards, C. F. Weber & Co., San Francisco, $1563.16; painting, C. L. Wold Co., $4017; electric work, Golden State Electric Co., San Francisco, $7742.10; plumbing, F. W. Snook, $9668; programme-clocks, Standard Electric Time Co., San Francisco, $1510; hardware, Bennett Bros., San Francisco, $4940; heating, Todd & Nottingham, Oakland, $19,254.

SACRAMENTO, CAL.—Weinstock, Lubin & Co. will construct reinforced concrete building. Estimated cost is $1,000,000.

Consolidated Chamber of Commerce will construct $75,000 building.

S. W. Waterhouse, San Jose, is having plans prepared for brick building to be erected on J street between 7th and 8th, to take the place of the one recently destroyed by fire. Estimated cost is $100,000.

Following were the bids received for construction of warehouse for Libby, McNeill & Libby: Palmer & Peterson (awarded contract), $120,000; Clinton Construction Co., $121,500; Mathews Construction Co., Sacramento, $124,300; H. L. Peterson, $124,339; Lindgren Co., $131,877; Lange & Bergstrom, $136,750. All San Francisco firms unless otherwise noted.

Bids will be received until December 21 by W. F. McClure, State engineer, for construction of addition to building for Chico State Normal School. Plans from State Engineering Department upon deposit of $50 each.

W. J. Miller, 417 Market street, San Francisco, is preparing plans for four-story mill-construction building to be erected by Joseph H. Herspring.

SAN DIEGO, CAL.—Contract for construction of county tuberculosis hospital has been awarded to Chisholm & Jackson, San Diego, for $20,137.

SAN FRANCISCO, CAL.—Bids will be received until December 19 at office of quartermaster, Fort Winfield Scott, for construction of concrete building.

Contract for construction of Bellevue school in Jefferson school district, San Mateo county, has been awarded to Fred Warden, 534 Sussex street, San Francisco, for $15,000. Contract for construction of Castle school in the same district has been awarded to O. C. Holt, 110 Jessie street, San Francisco, for $16,770.

Contract for grading for brick buildings to be erected at Washington street and Van Ness avenue has been awarded to Eureka Teaming Co., San Francisco. Rousseau & Rousseau, 110 Sutter street, San Francisco, are architects.

Contract for concrete and carpentry work for reinforced concrete building for Mission Consolidated Realty Co. has been awarded to J. D. Hannah. Contract for excavation has been awarded to A. J. Reeder. Total estimated cost of building is $45,000.

Contract for construction of mill-construction building for Catherine Dunne Estate has been awarded to G. P. W. Jensen, 120 Market street, San Francisco, for $45,000.

SAN FRANCISCO, CAL.—Contract for alterations in Nevada Bank Bdg. has been awarded to Barrett & Hilp, San Francisco, for $11,833.

SEATTLE, WASH.—Contract for construction of apartment-house for G. L. Haley has been awarded to Hans Pederson, Alaska Bdg., Seattle, for $50,000.

SOUTH SAN FRANCISCO, CAL.—Moran & Co. will construct reinforced concrete building by day-labor. Estimated cost is $50,000. H. J. Brunnier, Sharon Bdg., San Francisco, is engineer.

SPOKANE, WASH.—Contract for construction of flour-mill for Sperry Flour Co. has been awarded to Burrell Engineering Co. for $350,000.

STOCKTON, CAL.—National Paper Products Co. has obtained permit for erection of first unit of its plant. Estimated cost is $400,000. Macdonald & Kahn, Rialto Bdg., San Francisco, are interested.

TACOMA, WASH.—Maurice Couchot, 110 Sutter street, San Francisco, is preparing plans for reinforced concrete grain-bins to be erected by Sperry Flour Co. Estimated cost is $125,000.

TRACY, CAL.—Contract for construction of pumping-plant for West Side irrigation district has been awarded to Lindgren Co., San Francisco, for $25,789. Cahill-Vensano Co. bid $29,150; Advance Construction Co., $29,887; and H. L. Petersen, $39,500.

VALLEJO, CAL.—Following bids were received at Mare Island Navy Yard for construction of extension to boiler-shop: Frank Gallagher, 180 Jessie street, $30,900; George W. Boxton & Son, $31,900; Knowles & Mathewson, $31,967; A. H. Vogt, $32,849; L. G. Bergren & Son, $33,472; Lange & Bergstrom, $34,343; Macrae & Layas, $42,865. All San Francisco firms.

Following bids were received for construction of refrigerating plant at Mare Island Navy Yard: Cyclops Iron Works, $23,269 or $21,589, according to plans; Vulcan Iron Works, $23,850 (awarded contract); York-California Construction Co., $25,570 or $25,046; Automatic Refrigerating Co., $32,621 or $30,307. All San Francisco firms.

Contract for construction of building for Santa Rosa-Vallejo Tanning Co. has been awarded to S. J. Weeks for $36,500.

Contract for construction of paint-shop at Mare Island Navy Yard has been awarded to Knowles & Mathewson, Call Bdg., San Francisco, for $56,977.

WASHINGTON, D. C.—Following bids were received for construction of post-office building at Bakersfield, Cal.: Charles Wright and Alfred Kohn, 110 Jessie street, San Francisco, $124,988, using limestone; H. S. Williams, $129,968, using limestone; Edwards & Wildy Co., $144,000, using sandstone, and $147,000, using limestone; C. L. Wold Co., $156,167; F. O. Engstrum Co., $133,897, using limestone, $135,197, using sandstone; Eugene Schuler, Pasadena, $135,000, using limestone, $140,000, using sandstone; William O'Neal, $135,453, using limestone. All bids have been rejected because too high.

Contract for construction of buildings and other work at Fort Stevens, Fort Columbia, and Canby, Wash., has been awarded to Dinwiddie Construction Co., Portland, Ore. Estimated cost is $91,000.

Contract for construction at Fort Winfield Scott has been awarded to Dinwiddie Construction Co. Estimated cost is $117,000.

Contract for construction at Fort Rosecrans, San Diego, and Fort MacArthur, Los Angeles, has been awarded to W. E. Hampton Co., Los Angeles. Estimated cost is $182,000.

Contract for construction at Fort Worden, Fort Casey, and Fort Flagler, Seattle, has been awarded to Sound Construction & Engineering Co., Seattle. Estimated cost is $182,000.

Following bids were received by Bureau of Yards and Docks, Navy Department, for construction of fuel-oil storage-plants at navy yards:

At San Diego: John H. Danforth Co., Buffalo, $356,901; C. C. Moore & Co., San Francisco, $373,159; Connor Bros. Co., New York, $424,435; Turner Co., San Francisco, $462,004.

At Puget Sound: C. C. Moore & Co., $447,233; John H. Danforth Co., $474,614; Connor Bros. Co., $479,240.

At Mare Island: C. C. Moore & Co., $427,682; Turner Co., $445,245; Connor Bros. Co., $534,715.

At Pearl Harbor: C. C. Moore & Co., $531,101; Connor Bros. Co., $556,050; John H. Danforth Co., $578,900.

## BONDS

ANDERSON, CAL.—Anderson-Cottonwood irrigation district has sold the remainder of its bond issue, $207,000 worth, to J. R. Mason, San Francisco, at 95.88 and accrued interest.

DELANO, CAL.—Bond issue of $45,000 for construction of water-system has been voted.

EL CENTRO, CAL.—Bids will be received until December 17 by Imperial irrigation district for the purchase of $1,500,000 worth of the bonds of the district.

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